FEBRUARY 1999

CLASSIC Hi-Fi

Hi-Fi News & Record Review special supplement No: 6

Hi-Fi News & Record Review incorporates Audio News, Audio Record Review,
The Gramophone Record, Stereo The Magazine, Tape & Tape Recorders and Which CD

IN THIS NUMBER

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- **Mariani's Museum: a unique collection of valves, radios and audio**

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- **An early 'Omni' speaker**
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★

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★

EDITORIAL

Welcome to the sixth edition of *HFN/RR*'s special *Classic Hi-Fi* supplement. Once again, we've put together an enticing mixture of new features and reprinted material from the archives (including ads!). As always, leafing through the back issues threw up some fascinating items, and this time we've picked some feature articles as well as equipment reviews. The cutting-edge videotape technology of 1957 [p25] seems almost unbelievably far from today's digital world, but the big news of that year was of course the launch of stereo [p26]. Looking back through the files sometimes tends to suggest that there's nothing new under the sun: the Germans, for example, were pushing omni-directional speakers back in 1959 [p22]. Coming forward to 1981, though, we republish Trevor Attewell's landmark review of a true original — the Quad ESL-63, which has stood the test of time as a reference speaker to this very day. And as a little tribute to Quad's great founder, now in retirement, we've also spliced in a half-page item from the same year, headed '25 years ago'.

The Editor

Cover picture: *from 78s to CDs... see page 4*

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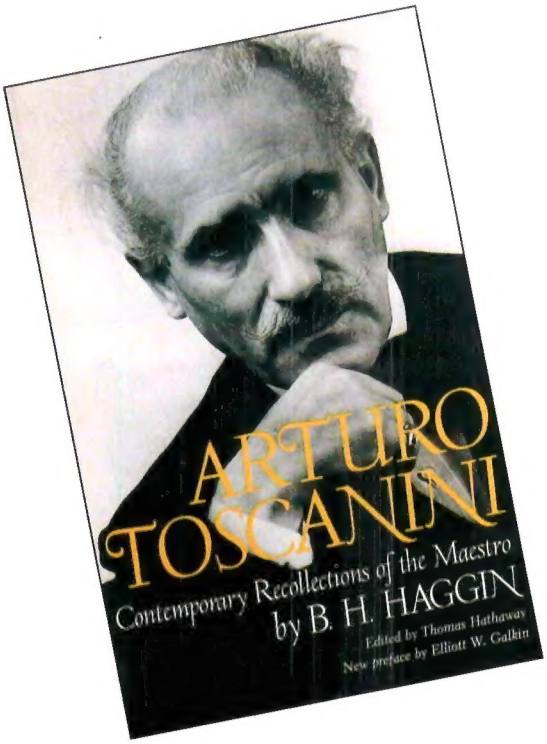
OLD WINE INTO NEW BOTTLES

Angus McKenzie describes the process by which old 78 rpm recordings are copied onto digital tape and edited to produce compact discs.



Up to 1926, all 78s were made by the acoustic recording process. A very heavy turntable was rotated at a (hopefully) uniform speed, and a thick heated wax disc was placed on the turntable. An arm containing a cutting stylus gradually traversed the wax disc, and the cutting head was lowered onto the wax at the beginning of the recording. The back of the arm was connected by sound tube to an enormous horn, which peeped through the wall of the studio, and the musicians had to play pointing their instruments, or voices, towards the opening of the horn.

Since low frequencies could not be played back on acoustic horns, the instrumentation had frequently to be changed, so that, for example, cellos and basses in a symphonic work were replaced by tuba or other low pitched brass instruments.

The recording horn had a low frequency cut-off too, so it is little wonder that recordings made before 1926 didn't have any bass on them. This does not apply uniformly to playback systems, as I found when I had the privilege of hearing an enormous horn system in a friend's home in Boulder, Colorado. He had a huge protoype horn player made by RCA in the 1920s, where the manufacturers had tried to rid the playback of all resonances, and furthermore, had actually achieved much more volume. Unfortunately, RCA never went ahead with the machine, due to its immense size; and in any case, electrical players had just begun to make an appearance.

Electrical recordings

In 1926, most of the world's record companies switched to electrical recording. The recording head containing the cutting stylus was fed by a powerful amplifier, and the stylus wiggled sideways as the audio current passed through coils in the head. Magnets were built into the head, the earliest ones being non-permanent and requiring DC energisation, and the result of the current passing through the coil in the presence of the magnetic field produced the movement in the stylus.

For many years, record companies used wax discs for mastering, but our very own Cecil Watts started using acetates for cutting masters long before the second world war. His company, Marguerite Sound Studios (later MSS Ltd) was the first to produce acetate discs for outside organisations. By the time the war had started the government had appropriated Watts's entire output for the war effort, so companies such as EMI had to continue using wax for some years.

The manufacturing process

Whether wax or acetate, the 78 master had to be electroplated after it was cut. This produced a disc with 'hills' instead of 'valleys', and thus required a very special pick up to play it back. This was only very rarely done, as it was important that there should be no trace of damage to the master. Just one playing with the special pickup could increase noise on pressings originating from the played master.

A record called a 'mother' was then electroplated from the master. This was a playable metal record, but again was only very rarely played to reduce the possibility of damage. Several 'mothers' could be taken from a master, but later ones developed a higher noise level. The electroplated masters and mothers were usually marked with a special matrix number, thus allowing experts to check which was the earlier pressing of a particular disc.

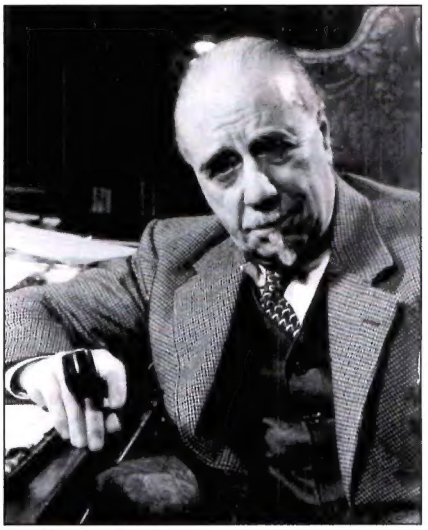
Many 'stampers' could be grown from a mother — yet again, there was a limit before serious wear took place, causing the shellac discs to become noisy and distorted. Occasionally, a disc enjoyed such outstanding sales that the original master wore out, necessitating re-recording. Thus later issues could be very different from the original. (The best known example of this was Ernest Lough's *Hear My Prayer*, on HMV 's 'plum' label. Lough's voice was just on the verge of breaking, and HMV's engineers recorded him just prior to that.)

Usually, many 'stampers'were made, allowing several presses to stamp discs. The process from master to stamper is practically the same for LPs today as it was 70 years ago, only the dimensions being different.

Groove size, groove noise and disc speed

Most people used iron needles (soon to be replaced by steel), but a few used thorn or fibre ones. The ubiquitous steel needles were of various dimensions, some with a curl in them called trailers, made for those with over-sensitive hearing, while louder, fatter ones produced a louder sound.

The difference between the quietest needle and the loudest could be as much as 10dB — no wonder many elderly ladies jumped when their grandchildren played their latest pop 78s with a 'loud' needle! Unfortunately, the harder the needle, the greater was the damage done to the disc



Sir Thomas Beecham

when the tip became worn. Steel ones wore very quickly and had to be replaced after each playing, although many people allowed them to be used for dozens of plays, causing irreparable damage to their discs. 'Long-play' needles were introduced lasting perhaps a dozen or so plays, but these also damaged the discs.

The truth about thorn needles will alarm many enthusiasts. Playback with these was quiet, creating less noise from the surface because of the softness. The needle had to be re-sharpened after each play — often during a play, especially for Wagner! This was a nuisance, but not disastrous. What proved over the years to be of concern was that thorn or fibre needles actually caused burning of the groove walls. This was the result of the poor heat conductivity of the organic material. Frequent playings tended to rip much of the high frequency content from the groove walls. Playback noise was lower, but one had to put in some boost to try and recover HF, and thereby increasing noise.

Today, LP collectors talk in terms of playing forces of about 1.5g, but some of the old blunderbuss pickups required a downforce of many ounces, eg, 200g. Take a badly worn disc that has been played with steel needles, and you can imagine the outcome! There were very few good quality electrical pickups for 78s until after WWII, so it is scarcely any wonder that old pressings in good condition are quite rare.

Nominal speed was not always 78rpm. Many British Columbias were recorded at 80rpm, and I have encountered discs requiring playback speeds of as low as 74rpm to as high as about 82rpm. An adjustable speed turntable is vital for dubbing, but there is another snag. Different countries used different pitches for their music, and it is not easy to work out exactly what is the correct playback pitch. [*EMI's remastering engineer Andrew Walter told me that in transferring the early Karajan material, he had first to determine to what pitch the Vienna Philharmonic would then have tuned* – **Mus Ed.**]

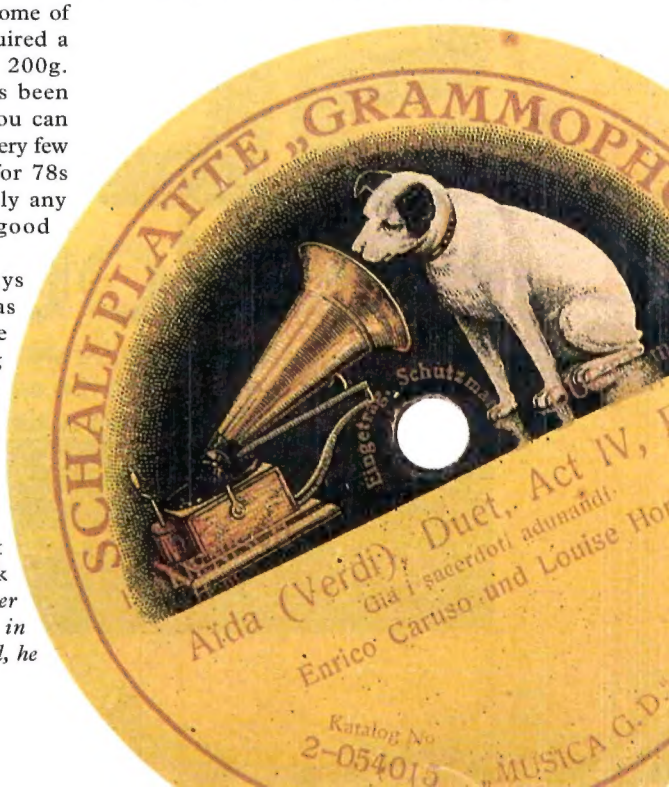
Groove dimensions were also variable — Decca's groove shape, for example, was different from that of HMV. The postwar Decca 'ffrr' groove was more V-shaped than those of HMV and British Columbia, so a choice of different playback diamond styli can be most beneficial.

Arnold Sugden, the designer of the famous range of 1950s Connoisseur turntables and pickups, actually made different heads for his older models. I had one with a 0.0025in stylus (known as the red head) for new discs, and a 0.003 tip (yellow head) for many older 78s. The difference between these was very dramatic, and the amount of distortion very obvious. Some years later, I was involved in dubbing 78s to 15in tape, and used a superb Ortofon series of pickups with different styli. By this time I had 'gone metric', using 65, 75 and even 90 micron styli to get the best out of all discs.

My Ortofon was probably the best for playing-back old 78s, but in more recent years I have used a series of Shure cartridges with special diamonds. I tried an elliptical one, which was an outstanding success on some discs.

Almost all discs were made of shellac, but some companies tried using a filler in the middle. Alan Blumlein, when he was the Chief Engineer of British Columbia, introduced a paper filler to the records made in the late 1920s; and I have no doubt that surfaces were far superior to those of HMV at that same time. The Columbia L series (immediately before the LX series) were extraordinarily quiet.

This becomes obvious when one hears CDs made from early-electric Columbias. Good examples of these are the series of discs made of some Bayreuth performances of Parsifal, and the remarkable recording of Lambert's Rio Grande, with Hamilton Harty conducting.



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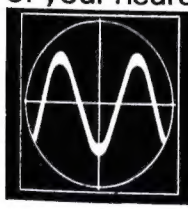

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Problems with some pressings

The first time I came across a bad 'swinger' was when I bought a secondhand copy of Holst's Hymn of Jesus, on 78s. One of the discs played-back with horrific wow; and looking at the cartridge, I could clearly see the pickup moving from side to side on each revolution of the disc. It was clear that the centre hole was completely out, the error being somewhat greater than 2mm. 'Swingers' could be produced by errors in positioning master, mother, or stamper. I heard that most samples of the Holst were bad, and one reviewer actually mentioned it in a review. I just had to grin and bear it for many years until it was available on an LP...

When old masters, stampers or mothers have been taken out of storage, it is sometimes found that verdigris has spread over the copper, or some other kind of oxidisation has occurred. It is extremely difficult to neutralise this effect. It is often better not to bother, but to clean the surface as well as possible rather than risk harming the groove walls. A form of water-marking can become apparent, and this is noticeable by a swishing noise for a few revolutions. In the worst cases, perhaps half of the disc is affected.

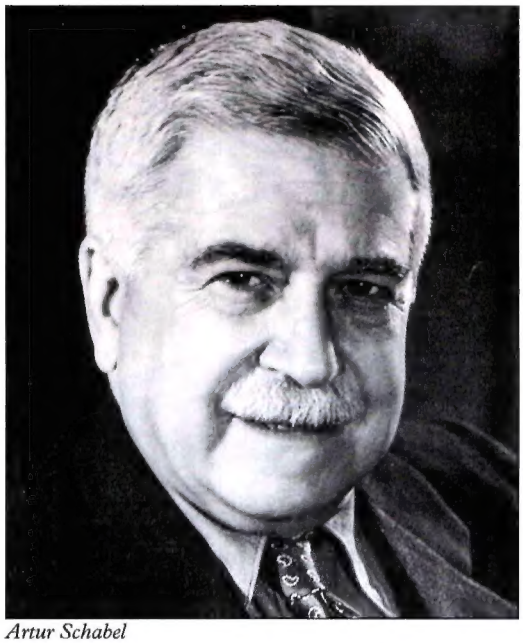
Shellac pressings can become warped, and on playback these can produce a form of wow. The careful choice of pickup can reduce this effect but it is difficult to eliminate it completely.

Scratch and noise removal

The engineer in charge of copying sessions may have taken years to find good pressings of the desired recordings. Mike Dutton (of Dutton Laboratories) told me that he frequently has to go through dozens of pressings to find an acceptable one. He uses the 'Cedar' digital noise reduction system; but another one is also available: 'No Noise', a US digital device.

The Cedar system seems to be more commonly used in the UK, and first removes scratches (impulse noises), then crackles and continuous noises ,including hum, air conditioning sounds and other background sounds. The system looks at the waveform before and after a scratch and decides how much actually to cut out either side of the crack. Careful choice of pickup is important here, and the wider and flatter the response between the playback of the groove and the digital noise removal system the better. The noise-reduction system can insert an appropriate chunk of sound taken as an average of the sound either side of the crack.

The degree of noise reduction is chosen as the best compromise between obvious high frequency loss and popping, and insufficient removal of crackles. Earlier digital noise suppression tended to be too violent, and I have heard far too many reissues with a hopelessly muffled sound, if admittedly with virtually no noise present.



Artur Schabel

The Cedar process can also perform basic noise removal. It can look at the contour of the noise, and cut a chunk of it out. There is no doubt that careful use of a device such as Cedar can perform what is almost a miracle on prewar discs.

The amount of hiss and crackle reduction considered optimal by different listeners presents quite a problem. I can remember, many years ago, doing a real-time analysis of some old 78s, and there was evidence of frequencies well above 7kHz on the disc. Yet all the old prewar text books made it clear that there were virtually no high frequencies over 6kHz. How wrong they were! Many early attempts at dubbing 78s to LP were dreadful. As often as not, too much HF was filtered out, making the copy useless for any further work in the future.

Not just the top end is important, but the bottom also. It is surprising how often studio-rumble shows up, but it offers the highlighting of low frequency instruments that would normally be missing from most playbacks. One can, with benefit, use an octave equaliser on playback to improve the sound. This can also compensate for the peculiar responses of microphones and cutting heads of old.

Vinyl pressings

If the original metalwork is in a reasonable state, it becomes possible to make vinyl pressings of the original 78s. CDs made from such originals can sound amazing, but it is necessary to have the co-operation of the original record company to obtain access to its archives. So much is found to be missing: first, as a result of the war effort in 1939–45, as metal parts were appropriated by the services; and later by accountants' demands that the companies reduce storage expenditure. 'New brooms' love sweeping clean, not realising the value of such wonderful historical documents.

Microphones

Early microphones were usually carbon types, and these produced quite a lot of distortion. Some of the early moving-coil types had dreadful cone diaphragm resonances, and it was not until the improved ribbon types arrived that recordings sounded better. Capacitor microphones existed before WWII, but were not common until after the war. Early mixers, through which the outputs of several microphones could be passed and mixed (sometimes this was done very badly) were originally passive, thus producing some hiss. Electronic mixers began to be used in the 1930s, but were inferior by today's standards. Distortion levels were fairly poor, even before the sound actually got on to the record.

One should consider the studio sound before the microphone pickup. Most studio sounds were rather dead, and many of the best recordings were made in concert halls. Some of the early discs on British Columbia were superb, and even the old Manchester Grammar School disc of 'Nymphs and Shepherds' sounded magnificent.

Early attempts at 78 record dubbing

Most companies were issuing 78s on LP as early as the 1950s, and the practice accelerated during the '60s. There were, however, no special noise reduction techniques used other than the use of carefully chosen styli. Many LPs were copied from metal parts, and some present-day copying is clearly done from early LPs. Unfortunately, too much HF was filtered off, thus leaving too little HF content upon which modern digital techniques can bite. It has been found

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far more beneficial to remove scratch, as opposed to hiss, by using gadgets such as Cedar or No Noise.

Around 20 years ago, two different electronic gadgets were released which could remove scratches and clicks from 78s. I demonstrated one of these on Radio London's Sounds Good programme. SAE, a US amplifier manufacturer, made a click suppressor, which took the difference channel between left and right outputs of a stereo pickup playing mono 78s and passed the signal on to the signal processor. This difference signal exaggerated any scratches, whilst cancelling out almost all of the modulation. The box knifed out the click, inserting a link made from the modulation from 'fore and aft', and allowed the listener to hear the result. Really bad scratches were miraculously knifed out, but lesser ones, although partially removed, departed with a very audible bloop. I found that this unit was only successful with really bad discs. Goodmans also made a click eliminator but it too relied on electronic techniques, and was only partly successful. Both units used what were called bucket brigade integrated circuits, to delay the main music signal, processing it after a very short time interval.

Elgar conducts: an electrical recording for HMV

Equalisation and filters

Equalisation is the modification or correction of the overall frequency response to achieve a required effect. Many push buttons are labelled 'filter', and these should cut the response steeply from below or above the turnover frequency. Unfortunately, most so-called filters are simple bass or top-cut circuits, often as crude as 6dB per octave. Few of today's pre-amplifiers have really good filters; modern signal sources should not really need them, but in the early days of hi-fi, pre-amps such as the Leak Varislope, and the Quad early models had filters which (if memory serves) approached 50 dB per octave. Good filters were usually used to cut frequencies above a point where the listener felt that little music was recorded, in order to reduce hiss and crackle, but at a cost. Filters involving chokes, or sharply-tuned circuits gave an effect called 'ringing', leading to harshness just below the filter roll-over frequency. Some recently produced reissues show this effect, when utilised rather than a process such as Cedar. A more gentle roll-off from mid-frequency takes too much life out of a performance, but still leaves in some HF hiss.

Adding reverberation

Many old recordings were recorded with a very dead acoustic, eg, the notorious Toscanini concerts in NBC's 8H New York studio, and although purists might not like such to be corrected, modern digital reverb devices are so good that a great and significant improvement can be brought to an otherwise dead recording. Sometimes, a little reverb can be added to the join between old 78 sides. This can mask the join, unless one can detect the slight change in the noises' characteristics. Some discs have had mono reverb added, but on some I can distinctly hear that the reverb is stereo!

Of course, the Nimbus technique adds stereo reverb from the sound reproduced in their studio, the originals being reproduced from an enormous horn driven by an acoustic transducer. The effect is interesting, and whilst purists might shudder at the concept, many listeners feel that the results from acoustic discs come over with a more acceptable sound. Whether Nimbus's technique is right or wrong is for the reader to decide, but their results are reliable and consistent. Background noise is minimal, and voices come over with that strange sort of clarity which I associate with horn-loaded transducers.

Concusion

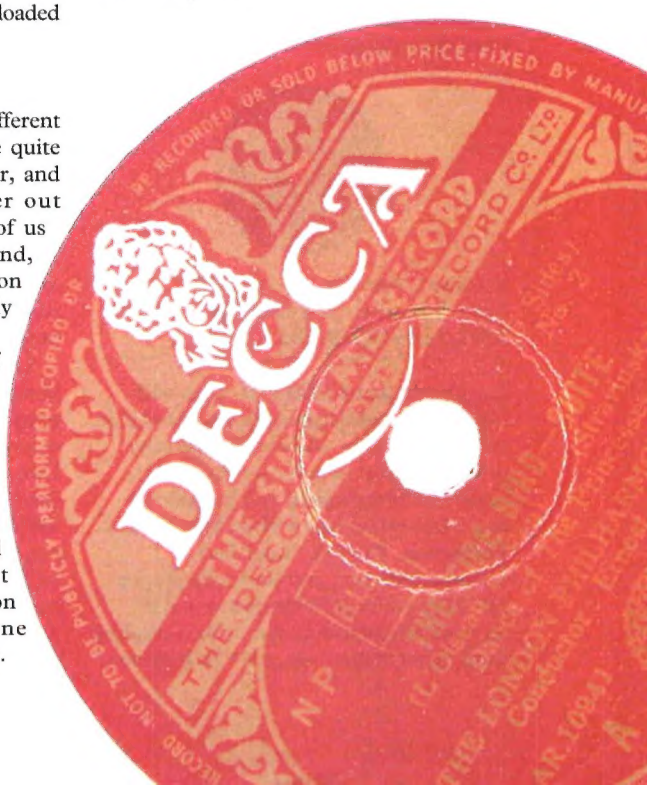
I hope I have convinced you that different issues of the same recording can be quite different in sound. Hiss is a bugbear, and many listeners just cannot filter out background noise mentally. Each of us has a different fatigue threshold and, strangely, I can take more distortion on old recordings than on relatively new ones.

I have heard the latest results of Cedar treatment of early tape-recordings, and it seems probable that the record companies may not tell us the whole story about the electronic treatment applied to their old tapes, let alone their reissues from 78s. It is a pity that Cedar did not make it mandatory that companies should put their logo on every transfer that has undergone treatment with any of their processes.

I feel that it is almost a miracle that we can now hear such old recordings sounding far better than they actually did in the recording booth, let alone from 78s on a wind-up gramophone. I hope that the record companies will take even more trouble over their issues of historic material.

Perhaps those brought up with 78s will be a little more tolerant of noise, and most of us do not want, or need, the ultimate in noise reduction on our favourite old recordings, especially if this takes away some of the brilliance of the original.

Cedar has made a valuable contribution to the recording world. If you are keen on early mono recordings, then give these reissues a try. I suggest that you may well have a surprise.



CLASSIC RECORDINGS ON CD

Beethoven: the 32 Piano Sonatas, with Artur Schnabel [EMI CDS 763 7652/Pearl GEMM CDS 9142]

My first CD set of these remarkable interpretations came from EMI, and was an early one using digital techniques. Although the basic transfers are just about tolerable, some of the editing and production is certainly not. On the first and second discs are some dreadful examples in which the transfer engineer has clipped the first note of a movement. (Listen to CD1, tracks 9 and 11.) Another sin is to bring up the recording level during the first note or bar of music: this occurs throughout the set; and it is so very annoying to hear the noise background rise with the music. I thought I could hear some wow and flutter, and I wonder if the discs were in fact copied from early LP transfers of the original 78s.

The Pearl transfers have been done with much more loving care, but the hiss levels are unacceptable to me and a group of a dozen friends who kindly listened to many comparisons. The openings of movements were discreetly raised just before any modulation, and the surfaces were almost devoid of clicks, which made me wonder if some click removal was carried out but with no other filtering of any kind. If only we could have had even a small amount of Cedar treatment, which would make the Pearl discs much more recommendable.

Schubert: Piano Sonatas, with Artur Schnabel [EMI CDS 764 2592/Pearl GEMM CDS 9271]

I again compared EMI's transfers with Pearl's, this time coming down heavily for the EMI, as there was a well-controlled noise reduction without too much HF taken out of the signal; and the fades in and out were far better done than for the Beethoven. The Pearl issue had unacceptable hiss, and even with a steep HF filter put in at 5kHz, this was still marked, in addition to the music sounding dead. Presentation was good on both sets.

JS Bach: Brandenburg Concertos, etc, with the Busch Chamber Players [EMI CHS 764 0472/Pearl GEMM CDS 9263]

Here, the situation is reversed, for the EMI issue has rather too much hiss, although the sound is good, whereas the Pearl seems just a little muffled, which sounds preferable to my ears. The EMI issue seems a little dead — typical of the era — but some reverberation has been added by Pearl. I think this enhanced my enjoyment; and I demonstrated that it had been done by summing the outputs of the two channels, out of phase. The difference channel cancelled out the direct sound but allowed the stereo reverb to be very evident. So here I suggest the Pearl transfers.

Mozart: Eine kleine Nachtmusik, and Haydn: Symphony 97, with Beecham and the LPO [Biddulph WHL 641/ Dutton Labs CDLX 1019]

This was a difficult comparison, with many changes of mind on my part. At first, the Dutton disc was preferred by some of my friends, but I was unsure; and one friend thought the Biddulph edition of both the symphony and the *Nachtmusik* sounded more lifelike. Listening very carefully, I am just about convinced that the Dutton is perhaps losing some of the natural reverberation from the studio. The sound is rather hard in the lower presence region, whilst the Biddulph, although a little noisier, does sound more natural.

The Biddulph disc also contains Handel's *Great Elopement* Suite and an overture. The Dutton disc includes an overture and Mozart's early Piano Concerto, K414, with Kentner. Most of the recordings come from a period in EMI's history that was not too good at producing hi-fi recordings. There is an odd story about Beecham's *Nachtmusik*: I heard from his family at the time that he was not too keen on the work, but HMV wanted to record it, and so Beecham was persuaded. But if I remember correctly, he took the final movement so extremely slowly as to cause the grooves to run very near the label, and the set was deleted remarkably quickly. The couplings may be a deciding factor, but if possible, go for the Biddulph. If I had not heard the Biddulph, I would have been content with the Dutton. So, is Cedar sometimes affecting the reverberation? A hard question to answer. The extraordinary difference could well be traced to the differences between US Victor and HMV pressings. Perhaps special vinyl pressings have less HF than shellac ones.

Beethoven: Symphonies 1 & 4, with Toscanini and the BBC SO [Biddulph WHL 008–9/Dutton Labs CDEA 5004]

There is a very great difference in the noise characteristics here, for the Biddulph has quite a high noise level whilst the Dutton one is so much quieter: better in almost all ways. However, for some odd reason, the beginning of 1(iv) has an odd distortion in it, rather worse on the Dutton disc. Perhaps it is an effect of the Cedar process. Furthermore, the end of the side-break on the last movt of the First Symphony is better done by Biddulph. I would have liked just a little reverberation added over side-breaks in general, which would have disguised them. These are among Toscanini's best Beethoven performances, and quite well recorded.

Mozart: Symphonies 39, 40 and 41, with Beecham and the LPO [EMI CHS 763 6982/Dutton Labs CDEA 5012]

The EMI set includes all the Mozart Symphonies that Beecham recorded before the war. No.39 was made around 1939, whilst the *Jupiter* was a little later, and far better engineered. I can only report that while there is virtually no noise in the background of the EMI, the sound is atrocious! It is highly coloured in the lower presence region, and is a

great disappointment. The Dutton reissue of these three last great symphonies is much better, however, and goes to prove that there is no need to cut absolutely all the noise that one can. The sound is more open, there is life in the performances, and one can hear a much more transparent sound, showing much that was missing on the 78s under the surface noise. EMI recordings made in the mid-1930s to mid-'40s were not all that good, as their main Abbey Road studio originally sounded very dead. The Dutton CD is highly recommended to Beecham lovers.

Elgar: historical reissues, sponsored and issued by the Elgar Society [Dutton Labs CDAX 8019]

Mike Dutton was approached by the Elgar Society to prepare this remarkable issue of recordings of Elgar's vocal music made from 1910 to the early 40s. It is one of the most important Elgar transfers in years, and about the best reissue of his conducting, so far as listening enjoyment goes. The Cedar process is working hard, but it has been very skilfully adjusted to keep as much of the original sound as possible whilst getting rid of an enormous amount of noise that was on some of the originals. I urge you to hear it, as there is so much to enjoy.

Wagner: early Bayreuth recordings conducted by Karl Muck – includes excerpts from Parsifal, and the Siegfried Idyll [Opal CDS 86843]

I had many of the originals of these recordings, and I am certain that my own copies were far quieter than those used for this Pearl transfer. If ever Cedar was necessary, it is essential here, yet evidently it was not used. What a pity, as the performances are historic. This *could* have been recommendable but the hiss is so bad as to render that impossible. The set desperately needs scratch and crackle removal, but hiss removal would have been even better. I can hear slight pitch differences from time to time, where sides were joined. It is curious that the second disc is much quieter than the first, the crackle level being much lower.

Sigrid Onegin: vocal items [Pearl GEMM CD 9224]

Pearl have done a good job here, allowing us to hear a truly remarkable voice from 70 years ago with a sound that is excellent. Onegin's voice is at times slightly like Ferrier's, but with a range right up to soprano. [*The Swedish singer made her debut as Carmen, with Caruso (Stuttgart/1912); notable roles included Brangäne, Lady Macbeth Herodias and Fricka.*] Listen to Mozart's 'Alleluia' from *Exsultate Jubilate*, especially at the end! This is one of my favourite historical vocal performances, and it seems that some crackle and scratch removal has been carried out, perhaps with Cedar. Incidentally, I was pleased to hear that Pearl's engineers had added some artificial reverberation, greatly enhancing the original dead sound.

Berlioz: Harold in Italy, and R Strauss: Till Eulenspiegel, with William Primrose, and the Boston SO under Koussevitzky [Dutton Labs CDEA 5013]

The original was recorded in 1945, and was a much better recording than, say, Koussevitsky's Beethoven *Eroica*. Primrose is balanced quite forward. Dutton Labs has made a superb job of this disc, and it has just the right balance between noise and the retention of HF. It is a very exciting account of *Harold in Italy*, which should be in every Berlioz collection. It is a pity that there are just a few prominent bass passages, including slightly-distorted timps, but this is typical of the period in the US. *Till Eulenspiegel* also fares well, with a very similar sound, again enhanced with a little artificial reverb. This was noted throughout the disc as modulation in the difference channel.

Bach: organ works performed by Albert Schweitzer [EMI CDH 764 7032/ Magic Talent CD 48045]

This offered a most fascinating comparison of the famous *Toccata and Fugue* in D-Minor. The EMI disc has much less HF noise on it, but was lifeless. There was a severe lack of bass, and I could not believe that it so lacking thus on the original. The Magic Talent version allows quite a lot more HF through; but even more marked is the excellent bass-register of the organ at All Hallows, near the Tower of London. Given that EMI should have access to excellent pressings, I am surprised that its attempt was not rather better. If you would like just one disc of Schweitzer, then try the MT.

The Brahms and Beethoven Violin Concertos, played by Szigeti (with Bruno Walter and Hamilton Harty) [Gemm CD 9345]

This coupling has been available for some time, and is highly recommended. The originals were surprisingly quiet, and were an excellent example of Blumlein's policy of filled shellac pressings. The CD would have been better with a little spit and crackle removal. It seems incredible that the Brahms was recorded as early as 1928, and the Beethoven in 1932: a lot better sound than so many American recordings even from 15 years later.

Handel: Concerti grossi Op.6, with the Boyd Neel Orchestra [Pearl CDS 9164]

It was an enormous undertaking for prewar Decca to record all the Op.6 *Concerti grossi* on 78s. When I was at school, my housemaster lent me them, one by one. What a joy it is to hear them so well transferred by Pearl! The originals were recorded at quite a low level, and were rather noisy, so this reissue shows all the better what a good band Neel's was. A good issue, and economic, on just two discs.

Overtures by Mendelssohn, Suppé, Nicolai and Rossini, with Beecham and the LPO [Dutton Labs CDLX 7001]

Why do so many collectors want to buy such old recordings? I guess it is largely because they bring back favourite memories. I had nearly all of the contents of this CD on LX Columbias, and enjoy playing such material to younger listeners to show them that interpretations of yesteryear were just as great as those of today. Beecham's grandiose manner shows up well with these excellent Dutton transfers. Just a little reverb has been most skilfully added. If the disc is played in double-mono, the reverb almost goes, and once again illustrates how dead the old EMI studio was before modernisation.

MARIANI'S MUSEUM

Giovanni Mariani is the founder and chief designer of GRAAF, the Italian company well-known for its high-quality valve amplifiers, particularly OTL designs. But Signor Mariani is also a collector. On a recent trip to Italy we were privileged to examine the collection, and to record this rare interview

BY KEN KESSLER

KK When did you start collecting antique valves and radios?

GM Radios, towards the end of the 1960s, and valves, which was a logical extension of the radio collection, around the mid-1970s.

KK At the time, were you the only one collecting this kind of thing, or were there others like you?

GM I was the only one, and to tell the truth people thought I was crazy. They would often ask me 'why on earth are you collecting all that useless old junk?'.

KK So we can assume then that old valves and old radios were very inexpensive to buy when you started?

GM In the early days yes, you could find the ordinary items for next to nothing. Of course, for more refined pieces one had to pay more. And recently the cost, particularly of the rare pieces, has become very expensive.

KK When you started, were these things plentiful and easy to find, regardless of price?

GM Even in the early days it was difficult to find exactly the things I wanted. Sometimes I was able to buy pieces in jumble-sales and local markets.

KK What is the oldest valve in your collection?

GM The very oldest is a valve by DeForest, made around 1913.

KK Which is the single rarest valve in the collection?

GM One certainly is the 3NF, a triple-triode integrated circuit valve.

KK How many valves do you have altogether in your collection?

GM If you mean the rare ones, the real collector's valves, probably less than one hundred; but if you add in all the antique valves from radios and so on, there must be several thousand at least.

KK And the oldest radio in the collection?

GM There is a gallenium radio, made by Marconi in about 1921. It has a very interesting method of tuning. To change the wavelength you push or pull on this lever, and insert different tuning coils. This is the crystal, and this is the headphone.

[***Steve Harris*** sees very early BBC logo: 'Ken, you've got to see this!' ***KK*** Wow!]

KK Is this British?

GM Yes, Marconi's company was based in England at the time, and indeed still is. His early radios were branded like this, up until 1924. After that date the brand mark changed.

KK It says here 'Approved by the Postmaster General'.

GM Of course, those were the regulations at the time.

KK Are you still actively collecting?

GM Yes, but the problem is — as you can see — this place is completely full. There is not a square centimetre left to put anything. So in practice I hardly ever buy anything nowadays: only if I see something really special, then of course I have to buy it.

KK Is there anything missing, anything you desperately require?

GM Yes, I would really like to find one or two audio amplifiers from the 1920s. Because all I have from that era is one USA Western Electric, and one English Western Electric amplifier which uses small valves. These are from the beginning of the 'twenties. I also have another from about 1930. So there is a gap that I would dearly like to fill.

SH Were these audio amplifiers used in public-address systems or were they for domestic use?

GM They were used in broadcasting.

Mariani's receiver collection starts with the earliest days of radio broadcasting

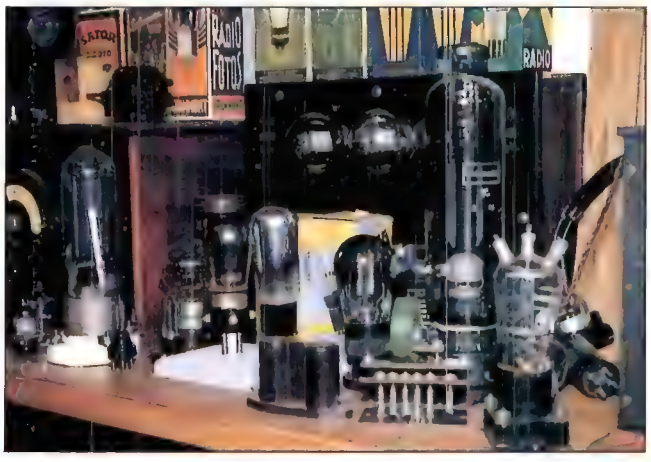
KK What is your favourite vintage radio?
GM An Italian Ramazotti radio, not because it sounds good — that would be asking too much from a vintage radio — but I like it because it is handsome and very well made. Early radios did not sound good at all, in fact it is not until the mid- or late-1930s that the sound quality became reasonably good.
KK Of all the obsolete valves, is there one that you would have been able to use in one of your modern amplifier designs?
GM There are quite a few, even those dating back to the 1920s. Nearly all the Western Electric valves of that time would be usable today, if only they were still available. The same is true of valves from companies like RCA, GE and Marconi-Osram. And in fact there are people today making special one-off amplifiers using these early but perfectly valid valves.
KK In your personal opinion, which was the greatest valve manufacturer of all time?
GM If you mean in terms of the quality of their products, I believe it must be Western Electric.
KK Do you have an all-time favourite valve, one that you regard as the very best?
GM To tell the truth, there is not one single valve that I prefer above all others. As a designer, it all depends on what you want to achieve. Some valves are better for certain applications, others for other applications. But if you press me, I could mention one or two.

For example, the American type-50 or 250 valve from RCA was good in days gone by, and it is still good today. Or the Western Electric type 205 was another excellent valve.
KK Of all the various types of amplifier circuit, why do you prefer the OTL?
GM In 1982 there were three of us here in this very house, and we were discussing this same subject. To be precise, which were better, valves or transistors? We discussed this subject long into the night, without coming to any definite conclusion. Because it was perfectly clear that some things are done best by valves, and some things are done best by transistors.

So I decided to make an amplifier, using valves, but with a circuit similar to that of a transistor amplifier. By that I mean, without any output transformer, and directly coupled just like a transistor amplifier, so that in effect there would be none of those things in the signal path that can give a particular sonic 'character' to the amplifier. I wanted to make something that could be used as a test bed for comparative purposes.

After about a year my first OTL was ready. I don't mean the GM200, which followed some six months to a year later. This first OTL was what I needed to be able to carry out the comparative tests I had in mind, between valves and transistors.

To do the job properly, I needed it to be not only output-transformerless and output capacitor-less, but also fully direct-coupled between the amplifier stages. That is how my work on OTL designs began.
KK Do you have a viewpoint on the trend in recent years towards single-ended triode designs, and have you ever been tempted to make one?
GM Over the years I have made many single-ended triode amplifiers, for friends and clients, and I must say that they have been very successful. If you ask me do I like SETs, yes I do: they are very good. But I have to say at the same time that for me they are just a little bit false. Let me explain. From the theoretical point of view, the OTL is a better system. But the single-ended triode is very persuasive, it can entice the listener and give much



This is the Lowther drive unit from a rare Harman-Kardon speaker

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pleasure.

SH What is your opinion of the 300B? Do you think that it deserves the adulation and praise that some people heap upon it?

GM It is a good valve, and it has good qualities, there is no doubt about that. But it is quite easy to make a 300B amplifier, which of course enthusiasts all over the world have done with much success. And this may be the answer to your question, for enthusiasts are always quick to spread the word of their success.

KK What led you to use the 6C33C valve in your latest OTL design [*the GM20*]?

GM Let me say straightaway that it was not I who chose the 6C33C. It was the valve that chose to make the amplifier! Because when you know this valve, then you also know this amplifier. It is in fact the only valve that allows you to make an amplifier of this kind.

SH You have some nuvistors in your collection. Have you ever tried to make an amplifier using nuvistors?

GM Only indirectly. Some years ago I experimented together with friends who were making nuvistor-based amplifiers. We found the sound to be good if rather false, but the main drawback with the nuvistor is that it is microphonic. In any case, I did not find that a nuvistor could do anything that other valves could not do just as well.

SH Is the sound quality of a nuvistor to be explained by its construction, which is so different from other valves?

GM The nuvistors which we tested were not the flat disc type, but with coaxial electrodes... and you get the impression that the sound they give when excited electrically contains a tiny amount of some sort of microphony that you can hear when you tap it. It very slightly exaggerates certain metallic sounds. It is almost as if exciting the nuvistor causes some very slight internal vibration.

KK Is there any way to get around that problem, for example if you were using them for a pre-amplifier?

GM If you wanted to amplify a very low-level signal, the output of a moving-coil cartridge for example, then you would never choose a nuvistor. It is much noisier than so many other valves.

KK How about in a line-level pre-amp?

GM Maybe. I have never tried them.

KK Do you think there will be any further development in valve design and technology?

GM Yes, I am sure there will be. One interesting development at the moment will be to make the best-sounding valve types with two to three *monoplacche* because in that way it should be possible to improve the sound quality and increase the power output. One company that seems to be working along these lines is the Czech company KR.

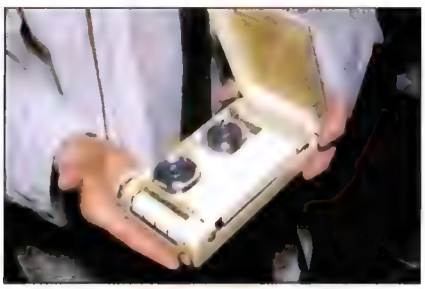
I don't know if they will succeed, but in any case the concept is right. From two to three *monoplacche*, it is a big improvement. It is just a question of doing it, and assuming that the valve maker is able to do it, the result should be a much better valve.

SH You are obviously interested in all parts of the audio system, but do you have any plans to manufacture anything other than amplifiers, loudspeakers for example?

GM You are quite right, I always have plenty of ideas in my head for things other than amplifiers. But the trouble is, there is never enough time. Anyway, working on loudspeakers is much too difficult, so I think I'll just stick to making amplifiers, which is what I'm best at.

● *Special thanks to Nick Green of UKD for transcription and translation of this interview*

Top left: the Minicom 'spy'recording kit from the mid 1950s (see also lefthand page). Top right: Giovanni Mariani with Nick Green of UKD (left) and HFN/RR Editor Steve Harris



A colourful display of 78 rpm needles; Mariani with a prized tube; and Mariani with Minicom recorder

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LEAK HI-FI

EQUIPMENT REVIEWED

Quad ESL-63 by Trevor Atwell Part 1

Manufacturer's Specification Full-range electrostatic doublet. **Impedance:** 8 ohms nominal. **Sensitivity:** 1·5 μbar volt at 1m (86dBA for 2·83Vrms). **Maximum input:** 10Vrms continuous, 40V peak programme for undistorted output, 55V peak max. **Maximum output:** 2 N/m² at 2m on axis. **Directivity index:** 5dB at 125Hz, 6·4dB at 500Hz, 7·2dB at 2kHz, 10·6dB at 8kHz. **Axis band limits:** −6dB at 35Hz (second order) and above 20kHz. **Supply requirement:** 200/240V or 100/120V 50–60Hz, 5VA. **Dimensions:** 925mm high×660mm wide×270mm deep, including base. **Weight:** 18·7kg. **Price:** £1000 per pair, including VAT. **Manufacturer:** Quad Electroacoustics Ltd, Huntingdon, Cambs. PE18 7DB.

THE EMERGENCE of the ESL-63 must be the longest-anticipated surprise in hi-fi history, and certainly one of the most welcome. It follows some 18 years of development (hence the '63'). Meanwhile the 'old', original electrostatic loudspeaker, continuous in production after fully a quarter-century, is still a standard against which others may be judged, notwithstanding its slight imperfections. This would be a staggering achievement in any field, and particularly in the fast-changing one of hi-fi. Quad's policy of making a real advance with each new product, followed by very long production runs and service facilities extending over decades, is in sharp and welcome contrast to the facile trendiness with which so many makers offer this year's perfect product, only to displace it next year with a minimally tarted-up version presented as even more shatteringly 'perfect'.

Before getting down to the review proper, it may be useful to offer some simple technical background, since the electrostatic principle often gets short shrift in the textbooks. Odd, when one considers that the reciprocal device, a capacitor microphone (the scale is different!), is by far the most important professional type, and for good reasons, most of which are shared by the ESL.

Fig. 1 represents a very simple ESL, though not a practicable one, as we shall see. B is a very light membrane which carries a positive electric charge, represented by +q, and is stretched between two plates A and C, Both plates are perforated with holes to make them acoustically transparent. The plates are connected to a transformer by means of which a potential difference can be produced between them. By connecting the centre of the winding to earth, the mean potential of the plates is made zero. When the charged membrane is inserted, it will attract electrons (negative charges) to the sides of A and C that face it—these electrons will come from earth through the transformer windings. Since charges of opposite sign attract one another, B will be attracted equally to A and C, and will not move. Now let a signal be applied through the transformer so that A is made more positive and C more negative by an equal amount. This is just another way of saying that electrons are transformed from A to C, so that the attraction between A and B is reduced, while that between B and C is increased by the same amount. This leaves a nett force acting on B to move it towards C, pushing air in front of it through C, and likewise drawing air in through A. If the signal polarity is reversed, the membrane will move the other way. Work has to be done in order to move the air, and this must come from somewhere. Electrically, the rate of doing work is given by the product of voltage and current, and in this case the voltage at any instant is that supplied by the transformer output winding, while the current is simply the electron flow between the plates A and C. In a simple, perfect capacitor no work would be done, and the current would be 90° out of phase with the voltage accordingly, but here the air motion introduces a loss, or acoustic resistance, to give an in-phase, dissipative component.

In this very basic explanation we have used mainly the electrostatic potentials, but in practice it proves more rewarding to consider the current flow into such small increment of area that makes up the total, and relate these to the air pressures that result at any given point in the sound field. This may sound involved, but it isn't really, and it leads to the result—rather surprisingly—that the acoustic performance of the loudspeaker can be totally described in terms of these currents. Those interested in pursuing the argument further should consult the paper *'New Developments in Electrostatic Loudspeakers'* by P. J. Walker, J.A.E.S. *28*, p.795 (Nov. 1980).

The electrostatic principle has a number of advantages over conventional moving-coil drivers. The moving membrane can have a very low mass, so that very little mechanical energy is stored in it and hence it will exhibit little overhang. It can also be driven all over its surface, avoiding break-up modes which are the curse of the moving-coil unit. The large area couples effectively to the surrounding air, avoiding the need for an enclosure and so eliminating possible colorations from reflections within an enclosure as well as from resonances in the walls. The system also has an inherently better distortion performance.

Naturally there are also some snags. To start with, a large, flat radiator is not much use at high frequencies (which is why tweeters are small). The reason is the destructive interference (cancellation) between sound waves from every pair of points on the surface for which the difference in path length to the listener is an odd number of half-wavelengths. This

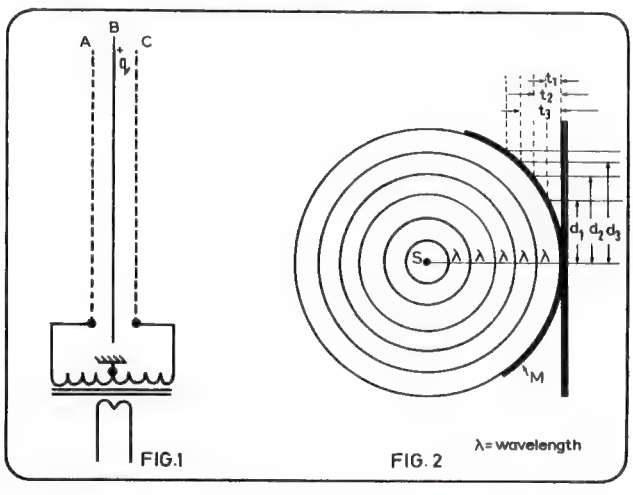
A) With the high operating voltage, it is essential that no dust be present. Vacuum cleaning in progress.

B) The electrodes are manufactured from sheet plastic with this ingenious jig to ensure even tension.

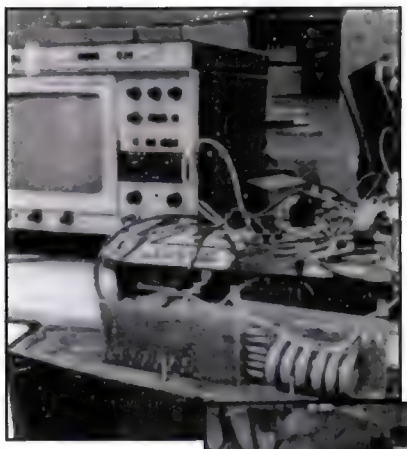
gives a radiation pattern with a sharp forward lobe and a set of annular side lobes at various frequency-dependent angles. Only the narrow front lobe will provide reasonable stereo imaging—not very much use! In the original ESL this is improved by dividing the frequency range between two outer panels, which shared the lower frequencies, and a narrower central panel used for the high ones. The vertical dispersion is extended somewhat by curving the panels about a horizontal axis. These measures result in a difficult and rather labour-intensive construction, while the listening area available for good stereo performance is still limited.

Next, we cannot simply have a charged membrane in isolation, because there is always some leakage, and the theory of operation calls for a constant charge. The membrane is therefore coated with a conducting film of negligible mass and very high resistivity, fed from an internal EHT generator which is connected between the membrane and the centre-tap of the transformer winding. This keeps the membrane charged, with a rate of change slow compared with that of the lowest frequency to be reproduced. The EHT is about 6 kV in the early model, and 5·25 kV in the ESL-63.

Another problem is that a high voltage electrode makes a first-class dust collector—the principle is used in the electrostatic precipitators that



Reproduced from September 1981 issue



C) (top left) *Electronic assembly completed, expanded metal screens are fitted to protect dust cover to and support cloth 'sleeve'.*
D) (top right) *Production line testing is thorough, ensuring that every ESL-63 is within a tight specification (1½dB). The 'doughnuts' in the right foreground are the inductors for the delay lines.*

E) The modular construction makes for ease of assembly and servicing. The photo shows the final stage before clipping-on wooden top panel: easing the cloth sleeve over the frame.

reduce particle emission from industrial chimneys. So a dust cover must be introduced—it must be a good seal, but it must also be acoustically transparent without adding any rattles. A certain amount of damping is also needed, because regenerative damping is not practicable.

In the ESL-63 the worst of these problems—that of controlling the radiation pattern in a predictable manner independent of frequency—is solved in a highly ingenious way. The argument goes like this—an ideal source (S in fig. 2) would be a single point radiating isotropically, for example, by pulsating in and out like a tiny balloon alternately inflated and deflated, giving spherically expanding soundwaves. So far, not very practicable—even if a source of this kind could be made, a sensible sound output would require an impossibly high amplitude at the surface. But, if we move away from the source, the total output power is spread over an area that increases with the square to the distance, giving an expanding spherical surface in which the air-particle displacement is correspondingly reducing. In fact, the neccessary displacement would be within reasonable limits at a spherical membrane M placed 300 mm from the source. If such a membrane could be constructed and made to move in the same manner as the wavefront at that distance, then the actual source could be removed without anyone being the wiser, provided that the membrane was between them and the source. Such a membrane would be a stinker to devise, but suppose a plane one is placed with its centre coincident with that of M, which is then removed. The radiated sound has reached the centre, and will arrive at a circle of radius d_1 after a time t_1, radius d_2 after time t_2, and so on. It will be seen from the diagram that if the differences between successive delay times are equal, the radii of the corresponding circles will get progressively closer as we move out. If the membrane is now placed between two perforated plates on which are conductors arranged in concentric circles, and the signal to be reproduced is fed directly to a central circle, and also through successive steps of a delay line to the outer ones in turn, then the membrane movement will be that of a plane through which the soundfield is passing—exactly what is wanted. As indicated above, the required far-field can be realised specifically in terms of the currents flowing, including a correction for the limited size of a practical membrane. This is truly an elegant solution, and its correctness is proved by the fact that it works just as predicted.

Turning now to the construction and circuitry, there can be but few who do not yet know what the ESL-63 looks like—a brown cloth covered rectangular section 820 mm high ×620 mm wide×145 mm deep in the middle, tapering symmetrically down to 82 mm deep at the edges, giving a rounded front and back, sandwiched between two similarly shaped boards of real wood top and bottom, and standing on a hollow plastic plinth which extends behind the main frame. On the top of the rear consist of four separate copper-coated and perforated boards of the type used for printed circuits. The top and bottom ones are completely coated, and the inner pair are divided into a central circle, five concentric rings and two outer symmetrical, but irregular, portions (all in two halves) by gaps etched out of the copper. The plates are about 5 mm apart, with the high-resistivity coated membrane supported midway between them. A sheet of a special cloth is inserted for damping purposes. A plastic dust cover, about 2µm thick, surrounds the 'sandwich', and the cloth cover is supported on an expanded-metal frame. Inside the plinth are a number of integral ribs and pillars which support a surprising amount of electronics. Impedance transformation between the input and the transducer is by two large, interconnected transformers at opposite ends. A mains transformer supplies the EHT with the aid of a Cockcroft-Walton multiplier, and also gives a low voltage which is bridge-rectified to feed protection circuits. The multiplier and protection circuits are on two small boards near the middle of the plinth. Directly below the main body two more boards hold the two six-stage lines that feed the sets of concentric rings on the back and front respectively. A small, separate board has a neon indicator, visible on removing a little plastic bung on the top of the plinth, whence it can be observed flashing while the loudspeaker is energised. This is purely a service aid, and there is no need to worry about how often it flashes, or whether both speakers flash at the same rate (they probably won't). The rule is—if it *sounds* all right then it *is* all right!

The protection circuits are particularly ingenious. In a conventional moving-coil loudspeaker any damage is normally due to overheating a voice coil, and the thermal time-constant involved allows plenty of time for a relay, driven by a circuit of greater or less sophistication according to price or maker, to remove the drive. In an electrostatic unit the damage is caused by an arc between the electrodes which burns a hole in the membrane. The arc is initiated following ionisation of the air, which occurs about three orders of magnitude faster than the operation of even a high-speed relay. Quad get round the problem with their usual flair. The first part of the protection is a soft-limiter that comes in when the input exceeds some 40 V peak, and does clever things at the input to the transformers without placing undue strain on the amplifier. This soft-clipping gives progressively more audible distortion, encouraging the operator to lower the wick. Should that person prove intransigent, ionisation will eventually begin, and will be detected by a small aerial built into the bottom of the electrode assembly. This signal is used to 'crowbar' the input for one or two tenths of a second, after which the circuit takes another look, and shuts down again if necessary. Amplifiers lacking short-circuit protection should not be used, therefore—most do incorporate it, but check with the supplier if in doubt. While the protection circuits are operating, power is being dissipated in resistors in the speaker. These can cope with normal music inputs, *ie,* intermittent overload, but continuous overloads must be avoided. Any steady-state test signal should not exceed 10V RMS.

In the event that an attempt is made to operate the ESL-63 with no mains input, and hence with the 'RF sniffer' circuit disabled, the audio input is made to crowbar itself at the safe level of about 8½ V RMS. This is essential, since the user cannot hear anything, and will tend to push up the gain to very high levels—we must all have carried out this illogical sequence at one time or another!

The first part of the listening tests involving a good deal of experiment with loudspeaker positioning. The ESL-63 is a doublet (hence the acronym FRED, or full-range electrostatic doublet) which radiates equally fore and aft, but not at all in the plane of the membrane. The basic polar diagram is therefore 'figure of 8', except that Quad, after much experiment, deliberately narrow it with increasing frequency, maintaining the symmetry about the listening axis. The ESL should not, therefore, be used with a wall close behind it. Quad point out that the *optimum* position for any loudspeaker is ⅓ of the way along the room diagonal, but acknowledge that this is seldom practical, suggesting a minimum of 600 mm from the rear wall. The polar response is such that the lateral and vertical room modes will not be excited if the loudspeaker is at right angles to the side wall. However, angling towards the listener is recommended, allowing a degree of excitation of the lateral mode. As long as there is enough space at the rear, some angling increases the path length of the rear radiation (and usually the number of reflections) before it eventually reaches the listener. In practice, the results from any doublet will be both room and position dependent, and there is no substitute for experiment to optimise performance. In my particular habitat the final position for each speaker was about 1¼ m from the end wall, with the nearer edge 200 mm from the side wall, angled to face the listener seated a little over 2 m away.

Several owners have reported a little chestiness when used on the floor, which was removed by raising the units about six inches or so. Quad say that this may occur in small rooms over shortened listening distances. My listening room is not small, but it does have a 'honky' floor

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of boards on joists with a small underfloor space, and I did notice the benefit of using blocks about 130 mm high under each speaker. Evidently this is also a matter for individual trial.

Having used the 'old ESL for many years, and found nothing to beat it for open transparency, particularly in the midband, I was not fully prepared for the degree of improvement achieved by the ESL-63, which actually makes its progenitor sound coloured! With the best input material one is first amazed and then delighted with the sheer realism of the sound, which places you where the microphones are, with the imperfections and size of the listening room as the only occasional intrusion. The stereo imaging is far better than anything else I have ever heard—the positional definition and image depth are astonishing. Unlike its older brother the image remains stable over a wide listening area, and the lack of any vertical or horizontal interference patterning as one moves one's head is unique and most refreshing. In a good source it is possible to locate, for example, individual players in an orchestra, and even to distinguish between two performers sharing the same desk! Compared with the earlier model the bass extension is considerably increased, with exceptional firmness, while a touch of chestiness in voices and a slight exaggeration in the presence region have both vanished. Transients are crisp, and the sheer detail in every sound is a revelation. Such superb performance makes a real advance in an area in which progress is now slow and expensive, and I find it hard to see how any multi-way moving-coil loudspeaker can be made to overtake the ESL-63, except in sheer output power. Indeed, a significant difficulty in carrying out listening tests on the ESL has been that of concentrating on sound quality instead of simply enjoying the music. What else does one want from a loudspeaker?

Naturally a reproducer of this quality shows up recording imperfections very clearly. There before you are the cardboard cut-out victims of the worst excesses of the multi-mike technique, the violins huddled in a little box on the left, the brass likewise somewhere else, and a singer (apparently in a different building) sticking out in the middle. There, too, are the pipe organs 150 feet wide with pipes arranged and diffused in a way never dreamed of by the builder. Thank goodness some early ESLs went to recording studios, where those who wish to hear what they are really turning out can do so! Certainly record reviewing will never be the same again, now that the really good stand out as clearly as the really awful.

For those who want to hear sounds at realistic levels down to 20 Hz or below, which means only those with access to original tape recordings of pipe organs, or electronic sources, a sub-woofer will be needed, as with any other loudspeaker that would generally be regarded as domestically acceptable. Here the ESL-63 with an Audio-Pro B2-50 (or 40) make an unbeatable combination—at a price!

So much for the quality—what about the volume? Significantly higher than the older version, and plenty to satisfy not only the classical listener but also a large proportion of pop fans too. For the really heavy stuff it will still be necessary to stick with the moving-coil, though, as it will if you prefer an 'exciting' (*ie*, unreal) sound.

This product is so important and so different in principle from the more familiar loudspeakers that it demands an unusually long review. Space limitations make it necessary to leave the measurements, which also call for some discussion, and the conclusion until the next issue. Perhaps no great psychic powers are required to guess the general nature of the final summary, but I will give those who only started at this paragraph a little hint—the review loudspeakers are being bought to act as standards against which other loudspeakers will be compared in future reviews. I should be delighted to find one that betters the ESL-63 in sound quality and imaging, but I would suggest that if you're going to read a book while waiting, you'd better make it a thickish one!●

Next month: the measurements

Peter Walker with his ESL-63

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Reproduced from September 1981 issue

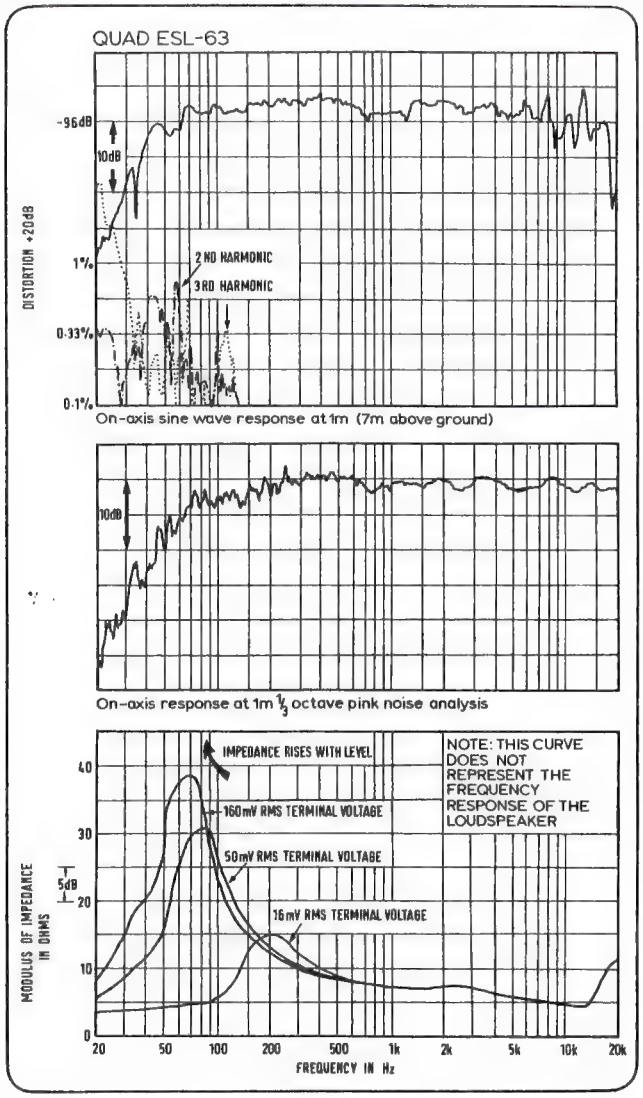
EQUIPMENT REVIEWED

Quad ESL-63 by Trevor Atwell Part 2

LAST MONTH we dealt with principles and realisation of the ESL-63, and with its subjective performance. Continued listening during the interim has proved to be absolutely compulsive, and a constant source of pleasure. Some excellent Proms relays have been available, and the sense of being physically present has never been sharper than with these units.

It is now time to look at the measurements, carried out as always by James Moir and Associates at about 7 m above ground in the open air. The sine response was taken at 1 m on axis, and is within ±2 dB from about 60 Hz to 8 kHz, being only 6 dB down at 35 Hz. In a room the ground reflection extends the bass response, and Quad have tailored the bass roll-off to avoid boom. A few peaks and troughs at the highest frequencies are partly due to reflections at the dust-cover, but our measurements are higher than those obtained by other laboratories. Since movements of the microphone produce some shifts in position and amplitude, and since we were measuring at 1 m instead of the 2 m for which the far field is designed to be flat, we suspect that this is another example of the influence of geometry on sharp features of the sine response, often produced by boundary conditions. Such features would not normally be audible, even if 'true', in a room, and were not heard. The third-octave pink noise response confirms this.

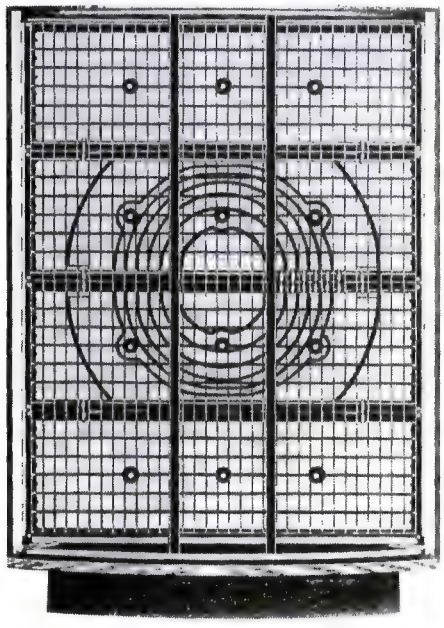
The distortion performance proved difficult to measure, because we were limited by the swept-oscillator distortion content! The distortion plot was amplified by 20 dB from 20 to 150 Hz, above which the loudspeaker distortion could not be measured by sweep methods. Single-frequency measurements at various points throughout the band



showed the distortion to be generally below 0·1%, and frequently as low as 0·03%, where it was close to the residual noise level. I have never seen results like these for a fundamental output of 96 dB spl at 1 m from any other loudspeaker. Even the levels below 150 Hz are better than almost all conventional designs, and the 3% second harmonic at 20 Hz (due to the rise in flux density in the input transformers) is quite respectable so far outside the intended passband.

The ESL-63 is unusual in having an impedance that varies with input level at low frequencies. We plotted the modulus for three constant-voltage inputs, and it will be seen that the impedance falls at very low inputs, for which the result is unimportant, the current demands on the driving amplifier being insignificant. The effect is due to decrease in low-frequency incremental permeability of the core material at low flux densities, and must be distinguished from the quite different effect already discussed in which an excessive peak flux produces distortion at low frequencies. In all significant areas of operation the impedance is substantially resistive, giving amplifiers an easy time except under gross overload conditions. This is another improvement over its predecessor, which presented the amplifier with a highly capacitative load, falling to a very low resistive value at a resonance (about ½ ohm at 12 kHz, if memory serves).

to p. 109



With its covers off the concentric rings of drive panels, each successively delayed going out from the centre and separated by the black lines, can be seen.

Our normal sensitivity check produced 93 dB spl of pink noise at 1 m on axis for one unit in an 83 m³ listening room for an input at the terminals of about 7 V, which is a good figure.

Under the general heading of tests it may be relevant to describe Quad's own routine test, which I watched at the factory. A square pulse is fed to one loudspeaker, and the audio output from a B & K microphone observed on a storage oscilloscope, which shows an incredibly good representation of the original pulse. Next, pulses of opposite polarity are fed simultaneously to two units, with the microphone in front and between them. Moving the microphone produces a null, which becomes a straight line with no more than 0·5 dB adjustment to one input!

This Quad design is a very real technological advance based on an elegant concept, followed by a painstaking practical realisation in which the basic ideas have been further refined. It may not be perfect, and I should be surprised if P.J.W. is not already gathering some long-term ideas for the future, but I find it extremely difficult to envisage how any multiway moving-coil arrangement can be made to compete in terms of accuracy, precision, lack of coloration and imaging. Some m-c units do make *some* recordings sound more exciting, or musical, or whatever is the current buzzword, but the ESL-63 is causing at least some recording engineers to take another look at their techniques, so the number of discs that can be 'improved' by suitable errors in loudspeakers may, hopefully, fall.

The listener who actually knows the sound and real excitement of live performances, and who wants to hear the true subtleties of music-making in any genre through loudspeakers, rather than the character of speakers via the music, is the natural possessor of the ESL-63, and will not easily be satisfied with less once they have been auditioned. The price is high, but it is justified, and the results are worth every penny. 'The closest approach to the original sound' has moved decidedly closer ●

Unlike the 'old' ESL, the ESL-63 is a true doublet. Those who particularly like the rear view can use them this way round.

Gramophile from p. 83

our sampling—the improvement to surfaces is generally large, often huge, and, we think, well worth the expense of replacing those least acceptable English Deccas from your own collection. (Sadly, Polygram cannot of course take responsibility for the pressing deficiences of the Decca company previous to their takeover.)

The sampling above happens to represent those releases most important to the Records and Music Editors (and most faulty in their own original English pressings); but the results give us reason to expect a similar improvement throughout the wide range of pressings previously affected by 'Decca Crackle' and progressive swish.

Tilson Thomas

Michael Tilson Thomas has been appointed Principal Guest Conductor of the Los Angeles Philharmonic Orchestra, sharing the main workload with the orchestra's Musical Director, Carlo Maria Giulini. At the end of November, Tilson Thomas begins his contribution to the first season during which he will conduct six weeks of concerts. Two projects he will be particularly involved with are a 'Stravinsky retrospective' and, to celebrate LA's bicentennary, a series of concerts comprising works written by composers while residents of the city, centring, of course, on Schoenberg and Stravinsky. Tilson Thomas will maintain his links as guest conductor with the Israel Philharmonic, the Concertgebouw, the ECO and Philharmonia.

Dell' Arte

Dell' Arte Records Ltd is a new, small record company being set up primarily to issue and reissue various recordings of outstanding historic interest. The initial launch in November comprises three reissues arranged in collaboration with the Leopold Stokowski Society. These are: a disc of the original 1920s and 30s Philadelphia recordings of various J.S. Bach works, including Brandenburg 2 and the (1927) Toccata and Fugue; some highlights from the 1952 recording of *Boris Godunov* with Nicola Rossi-Lemeni and the San Francisco SO and Chorus; and the 1976 Pye 'Overture' disc which includes *Leonora 3, William Tell, Giovanni, Rosamunde* and *Roman Carnival.* Future plans include further RCA and Pye reissues of Stokowski and previously unreleased material by Stokowski again, Toscanini and Siviatoslav Richter. There is some Koussevitzky in the pipeline, too. The records are being cut and pressed by Nimbus and will retail for £3·99. Further details from Philip G. Moores, 40 Marshall Lane, Greenbank, Northwich, Cheshire, CW8 1LA.

25 Years Ago . . .

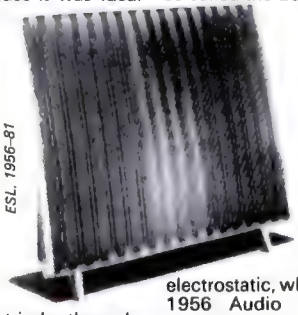
PJW, 1956

Corner ESL, designed 1955 but not put into production.

. . . in *Hi-Fi News,* 'Hi-Fi Boffins' surveyed the progress of a certain Peter J. Walker, from setting up business in March 1936 with a capital of £200. 'Things took a turn for the better in 1938, when they introduced a 30-watt P.A. amplifier, operating from A.C. mains or car battery. P.J.W. spent most of the year touring the country with it, selling it to dealers, who were most enthusiastic because it was ideal for hiring out locally, for sports meetings, fêtes, etc. As a result, he made many friends in the trade, and the P.A. business developed steadily in the next two years.

'In 1940 he built the first Acoustical Hi-Fi amplifier, the hard way, as a sideline. Push-pull triodes throughout, direct coupling, etc—and did not sell a single one!'

Wartime Government work intervened, as did the incendiary bomb that burned out the factory and prompted the move to Huntingdon. The second Acoustical hi-fi amp (1942) was built there for P. J. W.'s personal use '. . . rather large, and named the "Gastove" by the family.



ESL, 1956-81

In 1945, the PA business was resumed—along with the QA12/P hi-fi amp, the start of Acoustical's domestic amplifier success story that led through the still-classic 22/II/II and 33/303 to the current 44/405 combination. A ribbon speaker appeared and 'towards the end of 1948' P.J.W. started work on the original electrostatic loudspeaker (ESL: but perhaps it should now be called the ESL-48?). It was not until 1953 that he found it possible to apply personal 100% concentration to the problem. By that time the Company had grown, and the day-to-day routine work of sales and administration could be shifted to other brains and hands. The electrostatic, which was heard at the 1956 Audio Fair and B.S.R.A. exhibition, was the result. He says that the only occasions on which his nose was lifted from the electrostatic grindstone, in just over 2 years, were those on which he assisted Gilbert Briggs at the Festival Hall, London, and the Carnegie Hall, New York'. And here was the result: with, top right, more recent results.

GJ

ESL-63

PJW, 1981

EQUIPMENT REVIEWED

kugellautsprecher!

A GERMAN APPROACH TOWARDS THE OMNI-DIRECTIONAL IDEAL

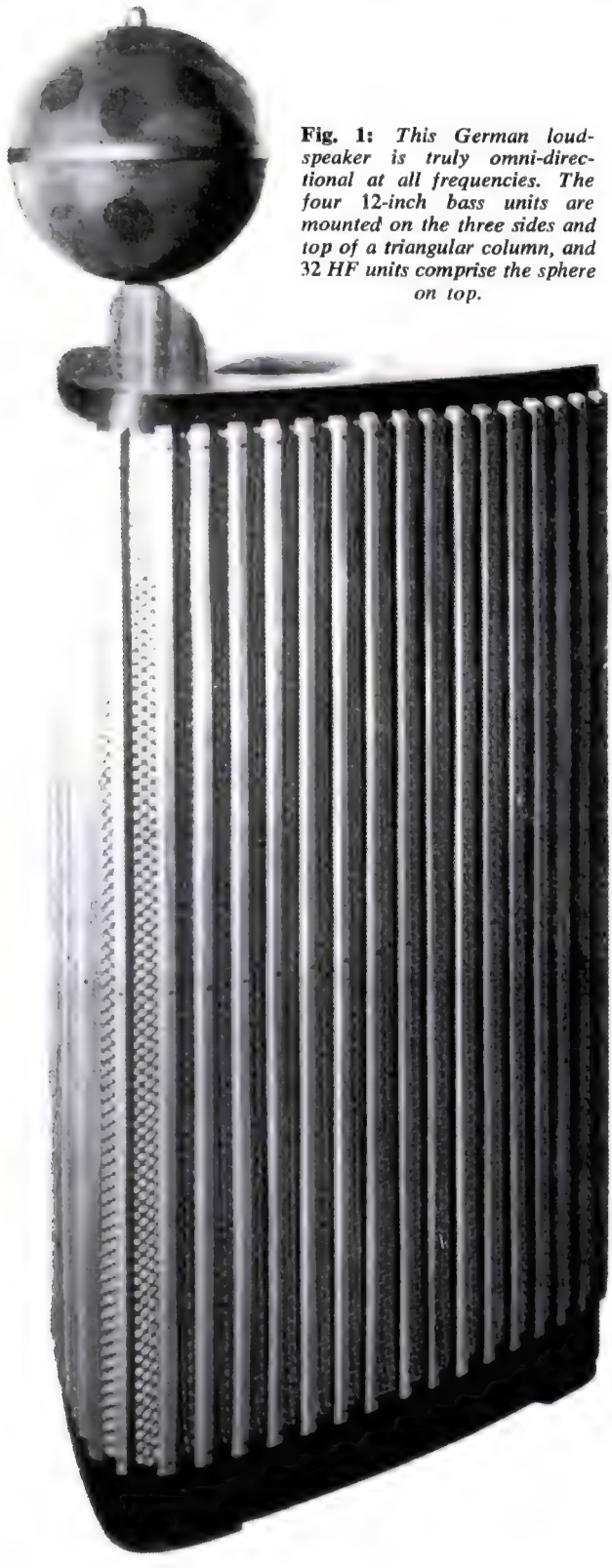


Fig. 1: *This German loudspeaker is truly omni-directional at all frequencies. The four 12-inch bass units are mounted on the three sides and top of a triangular column, and 32 HF units comprise the sphere on top.*

★ The ideal speaker is in many ways the true pulsating sphere —a suspended "balloon", with its whole skin able to vibrate and radiate sound waves omni-directionally, and with equal efficiency over the whole audio spectrum. Such a speaker may remain a perfectionist's dream for years to come; but this idea from Germany goes a long way towards the ideal, with four woofer units, and 32 tweeters in an HF sphere. We send our thanks to Dr. Enkel of the Cologne station of Westdeutsche Rundfunk for supplying us with the photographs and details.

THE photographs reproduced here show a loudspeaker of unconventional—and no compromise—design which is used for monitoring, balance and control in the broadcasting studios of Westdeutscher Rundfunk (WDR) and other radio and recording centres throughout Western Germany. The decision to employ a loudspeaker of the finest attainable quality in studios was taken because of the rapid growth of the VHF/FM service. Technically, the West German radio programmes are the best in Europe, and even two years ago some 2½ million VHF sets were in use in the Republic.

Why Omni-directional?

The engineers aimed at an omni-directional loudspeaker capable of giving the same high standard of reproduction in all four corners of the room, because of their special working conditions. Not only must the control engineer hear the programme faithfully reproduced, to enable him to mix, cue, and balance the various parts, but the rest of the production team too. These may include a musical arranger, script-writer, tape and effects operator, and of course the director, who expects to follow the programme accurately from anywhere in the room—even when he is pacing up and down!

Now it is pretty well established that equal radiation in all directions—i.e., true spherical waves—can be produced only by that academic impossibility a point source, or by the equally impracticable pulsating sphere. However, a good approximation to spherical waves is found to emanate from a source which is small compared with the radiated wavelength. This means that the low frequency sounds are fairly easy to deal with, from the omni-directional point of view—the wavelength in air at 350 c/s is approximately 3 feet.

32 Tweeters!

Getting omni results at high frequencies is much more difficult, and has been the subject of endless research and argument. Amongst the solutions that have been suggested—see the articles by Ralph West and others in previous issues of "Hi-Fi News"—are conical reflectors and acoustic lenses. But these merely achieve a degree of broadening of the HF beam, and in only one plane at a time.

The German approach, to fit together a large number of small loudspeakers in the form of a sphere, provides an ingenious if rather expensive solution. The design shown here was not worked out immediately. Several years ago a "ball-radiator" was constructed using 12 HF units. This did not produce a really consistent radiation pattern, but was felt to be a sufficient advance on earlier speakers to merit further research.

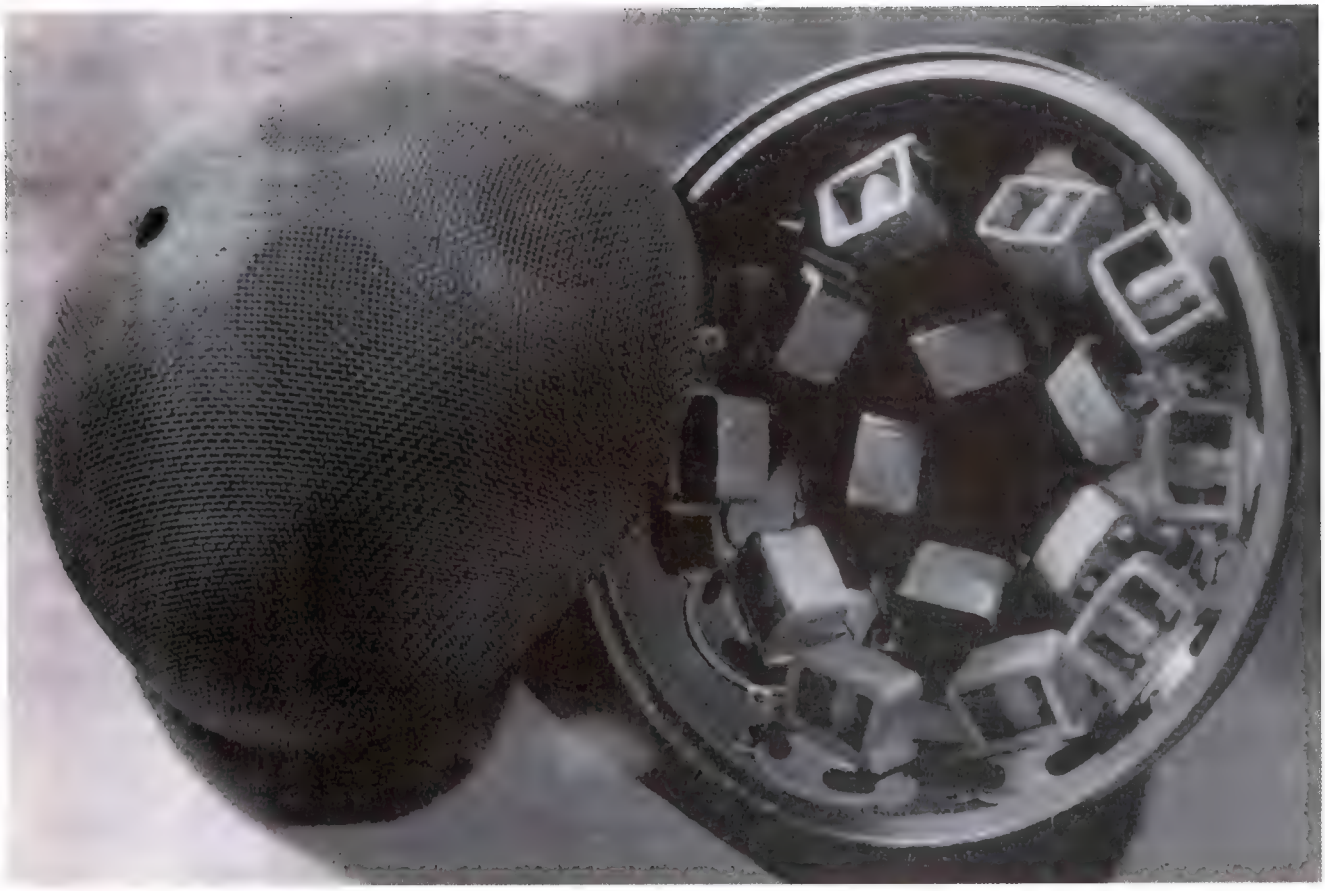


Fig. 2: *View inside the high frequency sphere. Sixteen of the small moving-coil units can be seen in the right hand hemisphere. They are bolted on to a specially-shaped baffle, and when the two halves are fastened together the unit is completely enclosed.*

An incidental advantage that comes from employing a fairly large number of units is that the total power is shared, and the cone excursions are proportionately reduced. This enables extremely low non-linear distortion figures to be achieved. Experiments by G. Buchmann have shown that a distortion factor of better than 1% can be got by limiting the speaker input to 0·5 watts.

In the present design, it was known that a total of 28 watts was required to produce the desired peak sound level of 92 phons (in control rooms measuring 120 cubic metres, and with reverberation periods averaging 0·4 seconds). Of this, 16 watts were taken to the high frequency section. To follow Buchmann's suggested figure of 0·5 watts per speaker, this indicated that the smallest number of tweeters should be 32. These are mounted on small hexagonal panels, and honeycombed together as a hecta-penta-tetra-octagon!

Low Frequency Enclosure

To eliminate the directional effects that are present even at low frequencies, and obtain a distributed load system, it was decided to use a number of LF units also. Enclosing four 12-inch loudspeakers in a triangular column, as shown, produced a very large radiating area, capable of efficient reproduction down to very low frequencies. The damping and general design of the enclosure followed normal practice, and any residual resonance effects were eliminated electrically by resonant equaliser networks pre-amplifier. This is shown in the photograph on page 733.

The usual electrical crossover unit is incorporated, to divide the amplified programme between the high and low frequency units. In addition, a more than usually complicated equaliser/pre-amplifier is used, whose frequency response is adjusted on each installation to compensate for the following: (a) Variations in response of the loudspeaker units themselves (b) Resonances in the two enclosures—sphere and column (c) Peaks between the two crossover frequencies (d) Eigentones in the control room (e) Frequency discriminating absorption in the room.

Producing a flat response curve at all points in the control room is a practical impossibility. With typical thoroughness, however, the WDR engineers set a test microphone at 10 specific positions in turn, and record a frequency run on a high-speed pen recorder. When the equaliser has been carefully adjusted to get the best overall response, and the loudspeaker's exact position is established, the pen recorder graphs are filed for each control room so that any suspected deteriorations in the reproduced quality can be checked immediately. The present writer was lucky enough to see this being done. As the pen recorder paper is semi-transparent, the maintainance engineer simply placed the test graph over the filed standard and, on holding them up to the light, any discrepancies were immediately apparent.

Characteristics of the Control Rooms

A great deal of trouble has been taken to relate the control room acoustics to those of an ordinary living room. Investigations suggest that the average reverberation time/frequency curve for domestic listening has a maximum value of 0·6 secs. at about 200 c/s, with smaller values at higher and lower frequencies. The control rooms were all designed to approximately this characteristic.

The level of listening of the studio engineers will almost always be higher than that of the average listener—to enable them to perform their various cueing, mixing, and controlling operations correctly. The volume control of the monitoring loudspeaker has therefore been given a "loudness" characteristic,

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Fig. 3. *One of the side panels has been removed to show the four 12-inch bass speakers. All the units are connected together in phase, and a special crossover unit is employed which can be seen fastened to the inside of one of the baffle panels. The power amplifier has been brought out to show the lower compartment. This amplifier is a standard studio design with a capacity of 30 watts.*

based on the Fletcher Munson graphs. The control takes the form of a sliding potentiometer marked in phons from 92 down to 56. For loudness levels less than 80 phons, the bass frequencies are less attenuated than the middle and high frequencies, so as to preserve the frequency balance as judged by the ear.

Conclusion

Thirty-two tweeters, four woofers, a small fortune spent on research and experiment before production, all this adds up to a very expensive loudspeaker indeed. And what of the results? The writer can report that the quality is excellent—with such efficient control of response over the whole frequency range, this is not surprising. However, the biggest innovation is certainly the all-round radiation. It was quite frightening to be able to walk all round the room and hear the same quality of sound. Even standing on a chair, and getting down on all fours produced no noticeable loss of high frequencies. Needless to say these antics greatly amused Dr. Enkel and his colleagues, who are justly proud of this "Schön hochwertige Kugellautsprecher".

* * *

Footnote: An interesting feature of the organisation in West German broadcasting is that the Engineering Division is allocated a fixed proportion of the licence revenue. They are able to use this to finance research and development of new equipment, as well as to buy the necessary components, etc., and the loudspeaker described here was therefore developed at the studios rather than in a laboratory. **J.B.**

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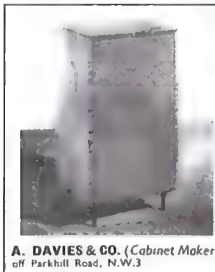

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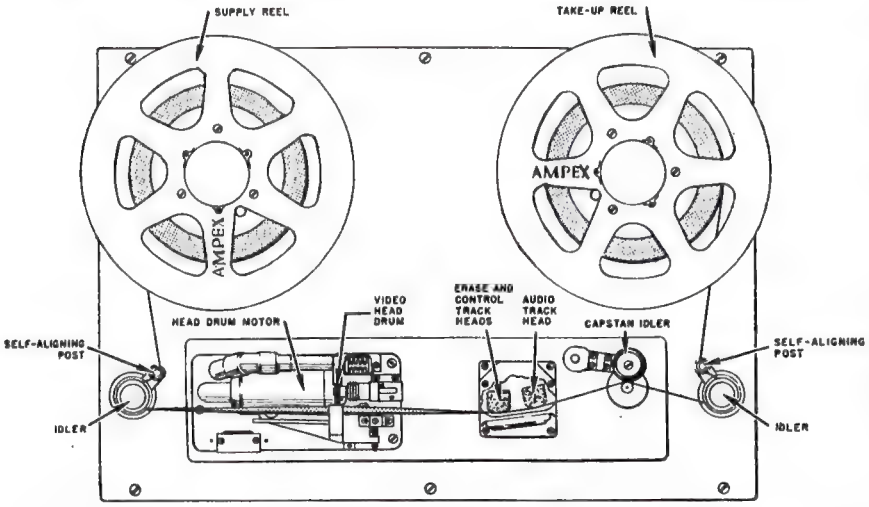
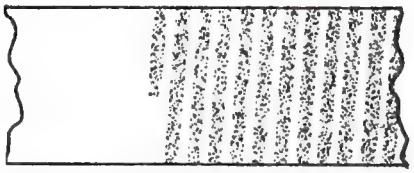
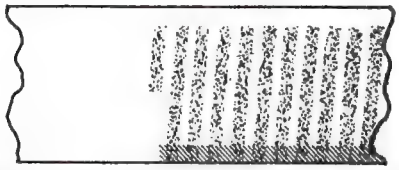
More Videotape Details



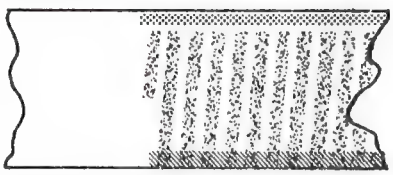
This first release of the Videotape layout shows how the 2-inch tape is scanned by the rotating video head, then receives control details and finally the audio signal.



SIGNAL PATTERN AFTER PASSING VIDEO HEAD DRUM.



SIGNAL PATTERN AFTER PASSING PAIRED AUDIO ERASE AND CONTROL TRACK RECORD HEADS.



SIGNAL PATTERN AFTER PASSING AUDIO RECORD HEAD.

GREAT progress has been made by Ampex since the introduction of the *Videotape* recorder some few months back, and it is of particular interest to note that American gossip is already busy with the rumours of Ampex plans for a domestic version of a T.V. tape recorder! Needless to say, this will not appear next week—but it will come, and sooner than many of us may think.

Only by noting the announced "improvements" to some equipment can one gain an idea of the difficulties that have been encountered and overcome. For instance, Ampex now say of their Videotape machine:

Since the *Videotape* Recorder presents the composite video signal, complete with synchronisation pulses, the recorder serves, during playback, as the source of "sync." for the transmission. New and improved methods of transferring "sync." from the *Videotape* reproducer to other "sync." sources have been devised and, when incorporated into production VR-1000 machines, will permit simple and rapid transition from studio, film or network tape and back again, with objectionable roll-over controlled.

Reduction in effect of "dropouts" is another important refinement. Momentary "vacations" in contact between head and magnetic material produce momentary interruptions in the output of the head, and therefore occasional faint, short streaks may appear in the picture As tape has been rapidly improving, through the co-operation of tape manufacturers, these are becoming fewer and briefer. Meanwhile, through electronic changes in the *Videotape* recorder, the brightness of these streaks on the rare occasions when they appear, will be matched to the general brightness of the picture.

When the two pieces of recorded *Videotape* are spliced together, it is necessary to splice precisely, so that waveform of the recorded control track will be smooth and continuous, and so that transition from one recorded tape to the next will occur at the end of a field or a frame. Since no picture is visible on the tape, and none is visible on the screen unless tape is in stable motion, editing by splicing will remain a very different procedure from that of film. Nevertheless, in order to provide for the insertion of "commercials", arrangements of back-to-back separately recorded material, etc., a magnetic locator now under development will indicate splice lines precisely.

Salesmanship !

Experience has now revealed many advantages of increased efficiency afforded by the use of a pair of *Videotape* recorders in one location. The ability to prepare tape copies by playing back into a second machine is of great significance from several standpoints: It allows the preparation of "protection" copies of important Videotaped programmes, it permits the easy exchange of tapes from station to station, and it facilitates editing operations.

A second Videotape recorder also allows back-to-back recording or replay when continuous programming on tape exceeds a one-hour period. When running spot announcements, back-to-back replay eliminates time-consuming editing for varied combinations of individual announcements. The pair of machines also allows more convenient scheduling of the equipment itself, since one can be programming on-the-air while the other simultaneously is taping a new show. Commercials can be inserted by the second machine within a taped show with ease and flexibility, and programme review for evaluation may be accomplished without tying up recording facilities unnecessarily.

Colour On The Way

The Ampex *Videotape* recorders now in operation and the production units now scheduled for delivery are for monochrome operation only. Many purchasers of this equipment have stated that the great operational savings which they will realise from the use of the monochrome *Videotape* recorder, and the many new sales opportunities which it opens, may pay for the expensive eventual conversion of their stations to colour.

Broadcasters, of course, expect to use monochrome cameras, films and Videotape side by side with colour—even after colour equipment becomes more generally used. While Ampex has issued no assurance that the present machines will be convertible to colour recording, colour research is going on diligently, with completion of the colour design expected to be about 18 months away. The slow tape speed of 15 inches per second, an all-important feature of Ampex *Videotape* recorders, will be retained in the new colour model.

The accompanying diagrams show the layout of the Videotape deck, and the complete signal pattern in its three stages.

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STEREO

By G. F. D

Almost exactly 80 years ago Thomas Ediso earliest recordings. A few years later, Em years ago the genius of A.D. Blumlein comb are about to see the culmin

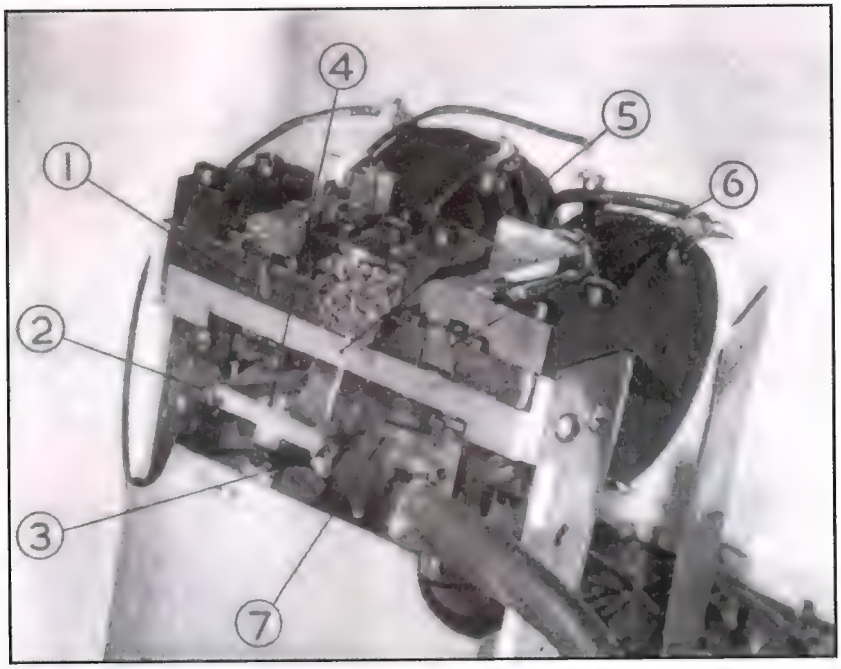


Fig. 1. *The experimental "moving iron" complex cutter head used by Blumlein in* 1933. *The armatures of the two heads are shown in* (1) *lateral and* (6) *vertical The stylus* (3) *is held by a tie wire* (5) *and is connected to the vertical armature by the link* (7) *and to the lateral armature by the links* (4) *and* (2).

THERE are several systems which are capable of giving stereophonic reproduction of sound. Whichever the individual system of recording, there does seem to be a general agreement throughout the gramophone industry that two loudspeaker channels are adequate to give a very satisfactory stereo effect when operating under domestic conditions. Considerable excitement has been created in the last few weeks due to a revival of the consideration of the commercial possibility of stereo recording on discs with two channels on one groove.

The idea of two channels on a single groove is not new, and in fact, the details of such a system were fully disclosed in a British patent 394,325, applied for in 1931 and completed in 1933 by A. D. Blumlein. This specification is extremely interesting, and while its main claims set out the principle on which the E.M.I. Stereosonic recording system is based, a large bulk of the subject matter covers, in a most lucid manner, the alternative systems for two channel recording on, and reproducing from a disc with a single groove.

The two systems mentioned in the above specification, and which are today under consideration in this country, the Continent and in the U.S.A., are variants of one system in which the motion of the stylus point is in one direction for one channel, and is at right angles to this for the other channel. Thus, if everything is properly balanced there will be no cross-talk between channels. The alternative arrangements are: (1) the stylus point motion for one channel is lateral, in the plane of the disc; and for the other channel the motion is vertical (hill and dale); (2) the motion of the stylus for one channel is inclined 45° to the surface of the disc, and for the other channel is inclined 45° in the opposite direction. These are illustrated diagrammatically in **fig. 2.**

Blumlein showed how a cutter head or a reproducer head designed for one system could be made to operate on the other system by suitably combining the electrical inputs or outputs of the transducers. A reproduction of part of the diagrams taken from the above patent specification are shown in **fig. 4.** He also showed that by suitably phasing the relative motions of the cutting stylus of the 45°/45° system, the motion resolved in the lateral direction could be made to give the sum of the two channels, while the vertical motion represented the difference. It has been suggested, in some quarters today, that this lateral component could be reproduced by a normal high quality lateral reproducer, thus opening up the possibility of a compatible record. This scheme may be dangerous, since most normal pickups cannot cope with the vertical component and the groove walls will be damaged due to the increased stress.

It can also be shown that a cutter

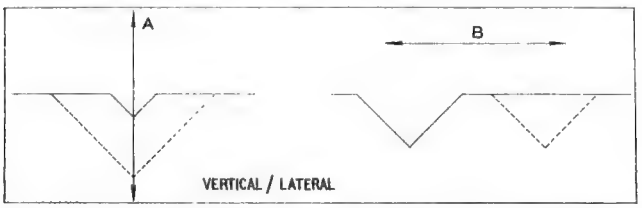
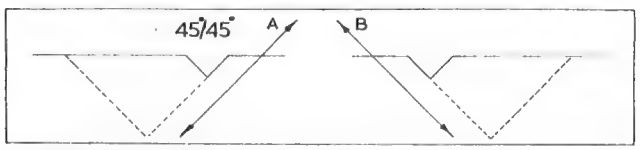
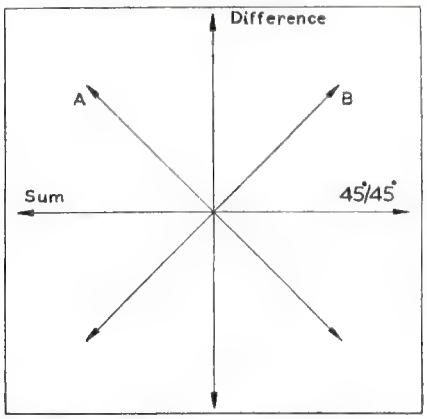


Fig. 2a. *The vertical/lateral complex cut groove is a combination of a hill-and-dale motion shown in* **A,** *where the limits of the vertical movement are set by the minimum depth of groove capable of guiding the replay stylus and the maximum depth (dotted)*



dictated by permissible maximum width of groove. The lateral movement **B** *is similar to normal l.p. operation and in the diagram the depth of the groove is shown as the mean depth when there is no vertical modulation.* **Fig. 2b.** *The 45°/45° complex cut groove is a combination of the movements A and B, each inclined at 45° to the disc surface and cut 90° to each other. The maximum and minimum cross sectional dimensions of the groove are set by similar*



factors to that of the vertical/lateral cut. **Fig. 2c.** *A and B represent the movements of the 45°/45° cutter and stylus, and if their relative phase is so chosen the resolution in the lateral direction can be the sum of the two channels and the resolution in the vertical direction will be the difference.*

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n used the Hill-and-Dale process for his il Berliner cut discs laterally. Twenty-five ined both systems for stereo, and to-day we ation of all this endeavour.

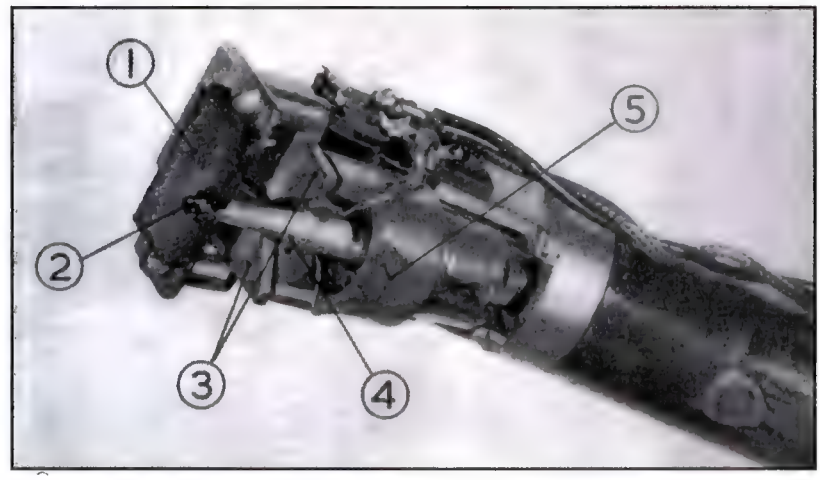

Fig. 3. *A photograph of the underside of a complex pickup used to replay the early stereo disc records. The stylus armature* (4) *is pivoted at* (5) *in such a manner that the stylus point* (2) *can move in the vertical and horizontal directions. The inclined pole pieces are shown at* (3).

head designed for the vertical and lateral system can be made to cut a groove with the modulation in accordance with the 45°/45° system. In order to allow these facilities the phase shift in the electrical-mechanical system must be small over the whole frequency range.

About the year 1933, experimental stereo recordings on wax were made under Blumlein's direction. These waxes were processed in the normal manner to produce shellac pressings. **Fig. 5** shows a magnified photograph of the lateral and vertical complex groove on a shellac pressing made during these early experiments. The variation of the width of the groove, corresponding to the rise and fall of the cutter point, can be seen along with the normal lateral excursion of the groove; this is the normal 78 r.p.m. coarse groove designed to operate with a 0.0024 inch radius stylus. The cutter head is shown in **fig. 1.** This is a combination of two "moving iron" cutters with the armatures mechanically linked to a common cutting stylus. The "moving iron" reproducer head is shown in **fig. 3.** This is a single movable arm carrying the stylus, and arranged so that the latter can move in any direction in a plane at right angles to the disc and normal to the direction of motion.

The complex motion is resolved into two channels by suitably combining the windings on the magnetic poles arranged at 45° to the plane of the disc. The reproduction quality in these early days was limited by the surface noise of the shellac pressing, and by the tracing distortion due to the large reproducing stylus. The frequency range was limited both by the cutter and the reproducer heads, and it was very soon found that reproduction quality could not be sacrificed in noise, distortion, or frequency range in order to obtain a stereo system. In other words, a stereo reproduction can only be fully effective if each channel is operating under very high quality conditions. The stereo disc therefore was shelved pending the development and improvement of the gramophone technique.

In the intervening years there have been one or two attempts to introduce stereophonic recording on disc. About the year 1952 Mr. Cook at Stamford, Connecticut, marketed 12in. diameter microgroove stereo discs recorded at 33 1/3 r.p.m. This was not

* *G. F. Dutton, Ph.D., D.I.C. A.M.I.E.E, is with E.M.I., International Ltd.*

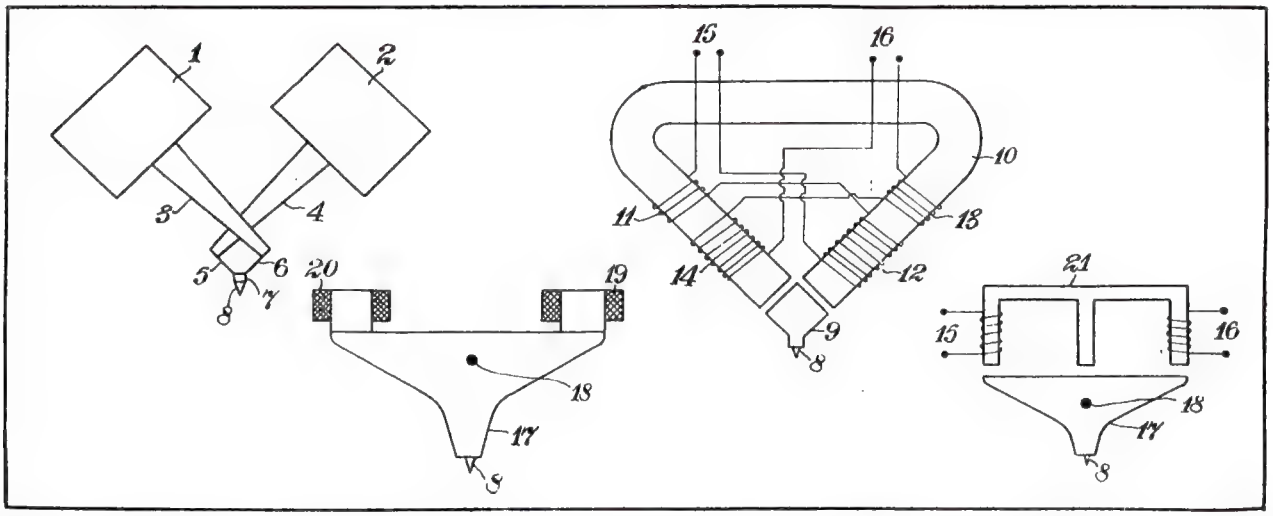

Fig. 4. *These diagrams were photographed from part of Blumlein's patent, No.* 394,325 *and are reproduced by kind permission of H. M. Stationery Office. In the diagram top left* **1** *and* **2** *are the transducers for the two channels, the armatures of which operate through levers* **3** *and* **4**, *and are connected to the stylus* **8** *by limbs* **5** *and* **6**. *The tie wire seen in photo* 1 *as number* (5) *is here represented by* **7**. *The remaining figures are alternative arrangements for a complex pickup in which,* top right diagram *represents the pick-up shown in photo* (3) *and the* left hand bottom diagram *is an arrangement for a moving coil version.*

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a single groove complex cut system, but a two channel system with one channel recorded on the outer half of the disc and the other on the inner half. The pickup heads were mounted on a common arm, with a micrometer screw to adjust the relative position of the stylus points. Adjustment had to be made in the reproducing characteristics to allow for the difference of frequency response on the inner and outer bands. The handling of the pickup combination was somewhat tricky and this, combined with the playing time limitations of about 12 minutes maximum, left much to be desired.

During the last two years A. R. Sugden of Brighouse, Yorkshire, has demonstrated, with equipment of his own design and manufacture, two channel disc recording using the vertical and lateral system. These demonstrations at the Audio Fair and the B.S.R.A. exhibitions caused considerable interest both at home and abroad.

In the last month or so the writer has been privileged to attend demonstrations, in this country by Decca and in the U.S.A. by Westrex, of recordings made in a similar manner to the above mentioned systems. Decca demonstrated the lateral and vertical systems, recorded with a high quality feed back cutter, developed by their German Associates, TELDEC, replayed with a complex pickup of their own design. The reproduction compared with the 7½in./sec. stereo tape equivalent showed an equally satisfactory stereo quality. Westrex demonstrated recordings which had been made with a cutter head assembly of two Westrex 1A feed back cutters, arranged to produce a 45°/45° modulated groove. These recordings were replayed with a 45°/45° moving coil complex pickup. Comparisons were made with the 7½in./sec. stereo tape equivalent and here also the performances were extremely close.

E.M.I. have been marketing a two channel stereosonic tape record since April, 1955, and the experience gained in producing master tape records has enabled this company to build up a valuable bank of stereo masters which can be transferred to disc whenever there is a general agreement on standards.

The revival of the stereo disc has been possible by combining all the advances in the technique of recording and reproduction of sound. The performance of the loudspeakers must not be forgotten, since it is most important that these should have a smooth response and a uniform polar distribution characteristic. The introduction of feed back in the cutter head system allows a more uniform and stable frequency characteristic, and the non-linear distortion is reduced to a negligible amount. The feed back also helps to maintain a uniform response under varying mechanical loading of the cutter point as may be experienced from the outer to the inner groove diameters. The heated stylus technique reduces the surface noise and allows the use of a keener edge to the cutting stylus. The radius at the bottom of the groove has been reduced to 2 or 3 microns (about 0.0001in.) and this allows the use of a smaller reproducing stylus, which will tend to counterbalance the increased tracing distortion and cross modulation of a complex cut groove. A diamond stylus point 0.0005in. radius has been found to be satisfactory with a playing pressure of 3 grams.

A pickup with a 12 micron point and which has been well designed for complex groove reproduction will track the latest normal LP discs satisfactorily, since most record companies have been operating with the small bottom radius of the groove for several years.

There are several important details which have yet to be completely resolved on the disc cutting technique. Owing to the greater space taken up on the disc by the complex groove, compared with the equivalent LP, a very efficient variable groove spacing and variable groove depth control must be used. The background noise, however slight, must be the same on each channel, otherwise its presence will be more annoying. Turntable rumble has a tendency to appear greater on the vertical channel of a vertical/lateral disc than on a 45°/45° disc. This must be overcome by improving the turntable bearing and the drive.

The pros and cons of the vertical/lateral and the 45°/45° systems are very closely balanced. There are no outstanding features in either system which would give it a decided preference. The final choice may well be with the pickup manufacturer, whose problem it is to combine two pickup elements in such a manner that they will have identical characteristics and low cross-talk. The mechanical linkage between the two elements and the stylus point must be so designed to give a wide frequency range to the overall system, and the mechanical impedance must be low enough to allow a light playing pressure on the small radius stylus.

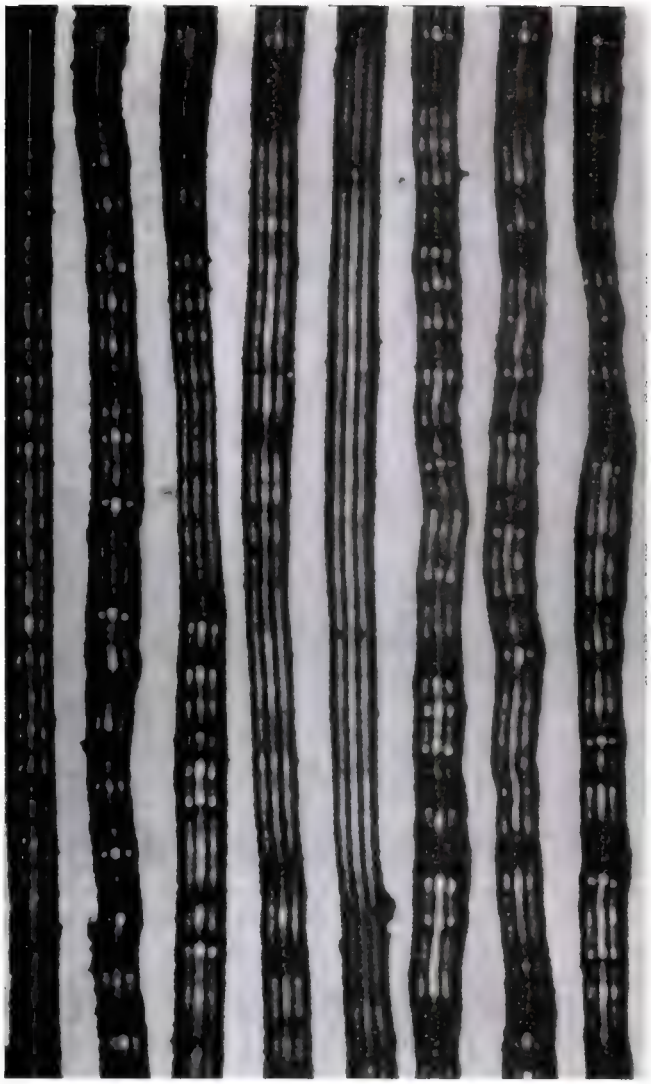

Fig. 5. *This is a photographic enlargement (×37) of a shellac 78 r.p.m. pressing, processed from a wax master, cut in 1933 with the complex cutter head shown in photograph 1. The section shown is a heavily modulated part of an orchestral recording. It will be noticed that one groove (top section of right-hand trace) is nearly at minimum depth, due to heavy amplitude of the vertical component. Those familiar with photomicrographs of modern l.p.s will notice a considerable improvement in today's processing techniques when comparing them with this coarse groove shellac pressing. Nevertheless, this picture is evidence of a very remarkable achievement of nearly 25 years ago. The principles of two channel complex recording and reproduction remain substantially the same today, and improvements in technique at all stages in the chain of events, from cutter head to loudspeakers, have made it possible to turn an early vision into a commercial realisation.*

The solution of these problems can best be achieved by a close co-operation between the recording companies and with consultations with the gramophone component manufacturers. Since the problem of fixing standards is world wide, interchange of ideas must take place on an international scale, so that recommendations can be drawn up which can be passed to the normal channels of the standardising authorities. We are happy to say that inter-company consultations at a technical level are now being actively pursued.

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equipment reviews

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ROGERS INTEGRATED STEREO AMPLIFIER HG 88

★

THE name "Rogers" has been well known in Hi-Fi circles for many years now, and the original Rogers "Junior" and "Baby" amplifiers have introduced thousands to top quality sound reproduction. The larger "Senior", Williamson-type amplifier has also been deservedly popular, as has the corner horn speaker system which ranks with the very best. Jim Rogers's demonstrations at Audio Fairs etc. have always been most impressive and musically satisfying. That being so, I expected a high standard from the latest Rogers stereo amplifier and I can say right away that I was not disappointed. The HG88 is a completely self-contained stereo amplifier and pre-amplifier housed in one cabinet, and is described as "an integrated unit". My dictionary defines integrated as "complete" and its use in this context is logical enough, but, although the term is used extensively in America, for some reason it has not become popular here. The HG88 uses fairly straightforward circuitry, but does incorporate some novel features. For instance, the volume control consists of a two-bank selector switch wired with resistors instead of the usual carbon track controls, and the variable filter control is connected in the Baxendall tone control circuit. A 5-position selector switch provides for inputs from every possible programme source, including direct from most tape heads and low output pick-ups such as the Decca ffss.

Circuit details

The first valve is the usual EF86 pentode, with the equalising obtained by means of a feedback loop. The heater voltage of this valve is reduced slightly to minimise hum and noise. This stage is followed by a ECC83 double triode, the second half being connected as a cathode follower to provide a low impedance input for the Baxendall tone control system, and more important to give a low impedance source for feeding to a tape recorder. As stated above, the variable low-pass filter is in the tone control circuit which uses one section of a ECC83 per channel. This is followed by the balance and volume controls, then a paraphase phase splitter feeding an Ultra-Linear output stage consisting of two ECL82 triode-pentodes. Power is supplied by two miniature twin contact cooled metal rectifiers connected in a bridge circuit.

Performance measurements

The frequency response was within 2 dB from 30 to 20,000 c/s, rolling off fairly rapidly from 25 Kc/s.

Hum and noise varied from –53 dB to –64 dB (reference 8 watts) according to input. The feedback loop measured 16 dB, and could be increased to 24 dB before instability became evident. Crosstalk between channels was –54 dB at 1,000 c/s and 40 dB at 10,000 c/s. The balance control had a variation of ±3 dB, that is a total variation of 6 dB.

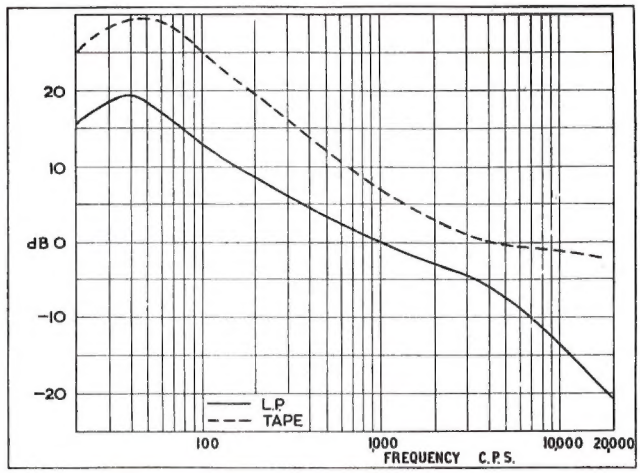
Power output

Frequency (c/s)	30	40	100	1,000	10,000	15,000
Watts (rms)	3·4	5·2	7·8	8·1	7	6·5

The tape and record equalising characteristics are shown in the diagram, and the effect of the built-in high-pass or "rumble" filter will be noticed. The bass control showed a lift of 14 dB and cut of 17 dB at 40 c/s, and the treble control a lift of 14·5 dB and cut of 14 dB at 9,000 c/s. The characteristics of the variable low-pass filter are shown in the diagram, and it will be seen that the rate of attenuation varies from 14 dB per octave at 5 Kc/s to 12 dB per octave at 20 Kc/s. The slight rise before cut-off at the lower frequencies was not considered very serious. Channel matching was within 1 dB for all settings of the controls — including the volume control.

Stepped volume control

Whether the expense of such a switched control is justified is another matter. Certainly it was a year or two ago, when it was impossible to get matched variable controls, but at least two firms make suitable controls matched to within 0·8 dB now. On the other hand, the switching noise with a step arrangement is not likely to increase with use, but a variable control with carbon tracks (although smoother in operation) may develop noise in time. The HG88 control proved quite with a small margin to spare, and on the tape replay position the gain was just enough to permit direct connection to the Truvox Mark 6 and Collaro "Studio" decks, both of which gave excellent results. For those who wish to use the mono coil of the Decca pickup or prefer

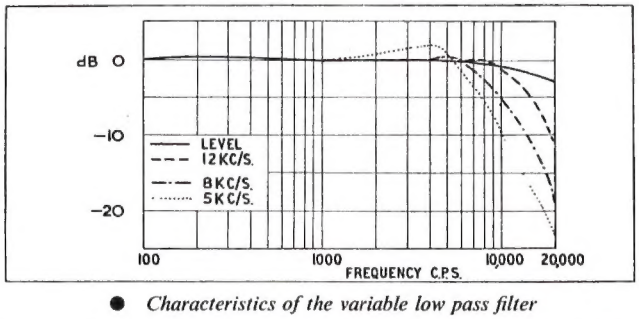


● *Equalising characteristics for tape and disc*

to use a separate pickup for mono records, a selector box is available at 30s. including panel and knob. The filter control worked very well indeed; both tape hiss and distortion due to record imperfections were considerably minimised without seriously affecting the musical values.

The unit is supplied in a figured teak case, and there is a choice of two panels—Brushed brass or Ivory enamel—with the appropriate knobs to match. Both panels were supplied with the particular amplifier tested, and my own perference was for the brass panel, but the Ivory finish will obviously suit some furnishing schemes. The cabinet itself is well made and most attractive, and a matching case is available for housing a transcription motor and pickup. Summing up, the HG88 will maintain the excellent reputation of Rogers for first-rate design and workmanship, and can be confidently recommended.

Manufacturer's Specification. Sensitivity: Pickup; 4 mV (adjustable) 150 mV adjustable; Tape; 4 mV CCIR 7½, Mic; 3 mV, Radio; 40 mV, Aux; 40 mV. **Tape record output:** 150 mV 10K impedance. **Frequency response:** within 1 dB, 30–20,000 c/s. **High-pass filter:** (built-in) 18 dB per octave below 25 c/s. **Low-pass filter:** 12–14 dB per octave 5 Kc/s to 20 Kc/s. **Bass Control:** ±15 dB at 50 c/s. **Treble control:** ±15 dB at 10 Kc/s. **Balance Control:** ±3 dB. **Crosstalk:** better than 40 dB. **Power output:** 8 watts per channel (peak sinewave). **Harmonic distortion:** 0·5% at 7 watts (inc. control unit stages). **Feedback loop:** 15 dB. **Hum and noise:** (Overall) –55 dB to 60 dB reference 7 watts. **Output impedance:** 3·75 and 15 ohms. **Operating voltage:** 110–125V 50–60 c/s, 200–250V 50 c/s. **Consumption:** 85 watts. **Valve line-up:** 2 × EF86, 3 × ECC83, 4 × ECL82. **Overall dimensions:** (inc. case) 15½ in. × 10½ in. × 7 in. **Weight:** 22 lb. **Finish:** Case; figured teak. Panel; Brushed brass or Ivory Enamel. Knobs; Brown or Ivory with ground brass inserts. **Price:** £40 with case; chassis only £37 10s. Mounting brackets per set 12s. 6d.



● *Characteristics of the variable low pass filter*

Manufactured by **Rogers Developments (Electronics) Ltd., 4–14 Barmeston Road, Catford, London, S.E.6.**

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